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beim Fachbereich
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Mit dem Thema:

"Socio-economic, environmental, care, health and nutritional determinants in the aetiology of severe protein-energy malnutrition in Southern Ethiopia (Sidama) with emphasis on kwashiorkor"

- A one year prospective and retrospective
follow-up study
to find out predisposing factors -

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We think sometimes that poverty is only being hungry, naked and homeless. The poverty of being unwanted, unloved and uncared for is the greatest poverty. We must start in our own homes to remedy this kind of poverty. (**Mother Teresa**)

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CONTENTS

ACKNOWLEDGEMENTS II
TABLE OF CONTENTS IV
LIST OF TABLES IX
LIST OF FIGURES XII
ANNEX CONTENTS XV
ABBREVIATIONS AND AGRONYMS XVII
TERMS AND ABBREVIATION XIII

1 INTRODUCTION I

1.1 Subject 1

1.2 Facts, relevance of the research topic and hypotheses 1

1.3 Objectives of the study 4

2 METHODOLOGY 5

2.1 Causal model 5

2.2 Study design 7

2.3 Variables, indicators and methods 10

2.4 Data analysis and statistics 14

2.5 Limitation of the study 17

2.6 Ethical consideration 17

3 GENERAL CHARACTERISTICS OF THE STUDY AREA AND STUDY SAMPLE 19

3.1 Study area and population 19

3.2 Food pattern in the Sidama zone 20

3.3 Protein-energy malnutrition - a major problem in the Saidama zone 25

3.4 General nutritional structure of the sample 25

3.4.1 Nutritional status of the index children 26

3.4.1.1 Methods ... 26
3.4.1.2 Results ... 27
3.4.2 Occurrence of nutritional oedema in the index children ... 31

4 BASIC AND UNDERLING CAUSES OF MALNUTRITION, ESPECIALLY OF KWASHIORKOR ... 31

4.1 General structure of households ... 32

4.2 Educational status of primary caregivers and heads of households ... 32
4.2.1 Method ... 33
4.2.2 Results ... 33

4.3 Economic situation of the households ... 35
4.3.1 Background ... 35
4.3.2 Method ... 35
4.3.3 Results ... 36
4.3.3.1 Monetary income ... 36
4.3.3.1.1 Absolute income ... 37
4.3.3.1.2 Income per capita ... 38
4.3.3.1.3 Gender aspect in income generating activities ... 42
4.3.3.1.4 Sources of income ... 43
4.3.3.2 Expenditures ... 50
4.3.3.2.1 Total consumption expenditures ... 50
4.3.3.2.2 Food expenditure ... 51
4.3.3.2.3 Absolute food expenditure ... 51
4.3.3.2.4 Food expenditure per capita ... 52
4.3.3.2.5 The budget share for food ... 54
4.3.3.2.6 Frequency distribution of PEM occurrence within categories of food expenditure ... 55
4.3.3.3 Qualitative description of food expenditure ... 56

4.4 Agricultural production and livestock ownership ... 67
4.4.1 Method ... 67
4.4.2 Results ... 67
4.4.2.1 Agricultural products and usage pattern ... 67
4.4.2.2 Livestock ownership, products of livestock and usage pattern ... 73

4.5 Families self assessment of their problems in daily life ... 76
4.5.1 Head of household’s self assessment of their problems ... 76
4.5.2 Caregiver’s self assessment of their problems in daily life ... 78

4.6 Food variety at the household level ... 80

4.6.1 Background and method ... 81
4.6.2 Results ... 82
4.7 Care for children as a determinant for the occurrence of nutritional oedema ... 86
4.7.1 Background ... 87
4.7.2 Methods ... 88
4.7.3 Results ... 89
4.7.3.1 Activity profile of caregiver and index child ... 89
4.7.3.2 Care index: index creation and results ... 93
4.7.3.3 Care and the occurrence of nutritional oedema ... 104

5 IMMEDIATE CAUSES OF MALNUTRITION, ESPECIALLY OF KWASHIORKOR ... 109
5.1 Illness background ... 109
5.1.1 Methods and hypothesis ... 109
5.1.2 Results ... 110
5.1.2.1 Period prevalence of diseases in the 14 days previous to the last home visit ... 111
5.1.2.2 Seasonal influences on the occurrence of diseases ... 112
5.1.2.3 Pattern of illnesses ... 113
5.1.2.4 Illness frequency of household members ... 120

5.2 Nutritional background of the index children ... 127
5.2.1 Breastfeeding and weaning practices and their relation to PEM ... 127
5.2.2 Food intake ... 130
5.2.2.1 Consumption frequency ... 132
5.2.2.1.1 Method ... 132
5.2.2.1.2 Results ... 133
5.2.2.2 Adequacy of the diet ... 142
5.2.2.2.1 Method ... 142
5.2.2.2.2 Results ... 142

6 ANALYSIS OF DETERMINANTS 163

6.1 Relations between certain determinants..163

6.1.1 Relation between the occurrence of illnesses and food diversity in the household and the occurrence of nutritional oedema 163

6.1.2 Relation between per capita income and food diversity..................... 163

6.1.3 Relation between per capita income and illness............................... 166

6.1.4 Care and its impact on the adequacy rate of food supply.................. 166

6.2 Multivariate analysis of determinants - comprehensive logistic regression of variables with significant impact on the occurence of nutritional oedema -...168

7 DISCUSSION 179

8 A TYPICAL HOUSEHOLD WITH A KWASHIORKOR CHILD IN SIDAMA,- A REFLECTION OF OBSERVATIONS AND DISCUSSIONS DURING HOME VISITS...221

9 RECOMMENDATIONS 235

10 SUMMARY 243

REFERENCES 249

ANNEX 275

PHOTODOCUMENTATION 307

LIST OF TABLES

Table 2 – 1: Variables, indicators and methods applied in the present study 11

Table 3 – 1: Nutritional status according to clinical classification of ex-patients (in %) 28

Table 3 – 2: Nutritional status according to classification of non-oedematous (NO) and oedematous (O) children (in %) after discharge from hospital 29

Table 3 – 3: Nutritional status by sex in non - oedematous (NO) and oedematous (O) children 29

Table 3 – 4: Sex distribution (in %) in post-kwahiorkor (PK) and post-marasmus (PM) children 30

Table 3 – 5: Nutritional status in oedematous children by age group 31

Table 3 – 6: Nutritional status in non-oedematous children by age group 31

Table 3 – 7: Sample of the study differentiated according to the occurence of oedema after discharge from hospital 31

Table 4 – 1: Education index of the parents from non-oedematous and oedematous children 34

Table 4 – 2: Education index of parents from ex-PEM and control children (Mean, median, SD, minimum and maximum) 34

Table 4 – 3: Frequency of kwashiorkor/ marasmus in households where woman were the sole earner of the household 43

Table 4 – 4: Sources of cash income for households with ex-PEM children and controls 45

Table 4 – 5: Frequency distribution of households for different sources of income (any income or 100% income), non-oedematous and oedematous group 49

Table 4 – 6 : Mean duration (hours) of activities of caregivers during one day, oedematous and non – oedematous group 90

Table 4 – 7: Mean duration (hours)of activities of the index child during 24 hours - oedematous versus non-oedematous children 91

Table 4 – 8: Mean, SD, median, minimum and maximum of indices concerning the care of children, oedematous and non – oedematous group 99

Table 4 – 9: Mean, SD, median, minimum and maximum of indices concerning the care of children, ex-PEM groups and control 99

Table 4 – 10: Indices belonging to care and their correlation to the occurrence of nutritional oedema 103

Table 4 – 11: Variables for index: behaviour of child 107

Table 4 – 12: Mean, SD, median, minimum, maximum of index: behaviour of child 107

Table 5 – 1: Period prevalence of diseases in two weeks previous to the interview at the last home visit (in %), non – oedematous and oedematous children 112

Table 5 – 2: Illness frequency in the pre-harvest season, ex-PEM children and controls 117

Table 5 – 3: Illness frequency in the post-harvest season, ex-PEM children and controls 118

Table 5 – 4: Illness frequency throughout the entire study period, ex- PEM children and controls 118

Table 5 – 5: Illness frequency of oedematous and non oedematous children in the pre-harvest season 119

Table 5 – 6: Illness frequency of oedematous and non oedematous children in the post- harvest season 119

Table 5 – 7: Illness frequency of oedematous and non oedematous children throughout the whole entire study period 119

Table 5 – 8: Illness frequency of other household members in the pre-harvest season, households with ex-PEM children and controls 120

Table 5 – 9: Illness frequency of other household members in the post-harvest season, households with ex-PEM children and controls 120

Table 5 – 10: Illness frequency of other household members throughout the entire study period, households with ex-PEM children and controls 121

Table 5 – 11: Illness frequency of other household members in the pre-harvest season, households with oedematous and non oedematous children 122

Table 5 –12: Illness frequency of other household members in the post-harvest season, households with oedematous and non oedematous children 122

Table 5 – 13: Illness frequency for other household members throughout the entire study period, households with oedematous and non oedematous children 122

Table 5 – 14: Duration of breast feeding (in months) by ex-PEM and control Children/non- oedematous and oedematous children 128

Table 5 – 15: Reasons for stopping breastfeeding in the groups (frequencies of caregivers answer in %) 128

Table 5 – 16: Drinks other than breast milk introduced to the diet shortly after birth in the investigated groups (frequencies of caregivers answer in %) 128

Table 5 – 17: Seasonal influence on consumption frequency of certain foods, ex-PEM children and controls 136

Table 5 - 18: Seasonal influence on consumption frequency of certain foods, non-oedematous (NO) and oedematous (O) children 139

Table 5 – 19: Seasonal influence on consumption frequency of certain foods, post-marasmic (PM) and post-kwashiorkor (PK) children after discharge from hospital 141

Table 5 – 20: Adequacy of the diet (in %) for main nutrients during one year, ex-PEM children and controls 146

Table 5 – 21: Adequacy of the diet (in %) for vitamins and micro-nutrients during one year, ex-PEM children and controls 146

Table 5 – 22: Adequacy of the diet (in %) for main nutrients during one year, post-kwashiorkor and post-marasmic children 147

Table 5 – 23: Adequacy of the diet (in %) for vitamins and micro-nutrients during one year, post-kwashiorkor and post-marasmic children 147

Table 5 – 24: P/E-ratio of diets in oedematous (O) and non-oedematous (NO) children in the various seasons 152

Table 5 – 25: P/E-ratio of diets in post-kwashiorkor and post-marasmic children in the various seasons 153

Table 5 – 26: Mean of percentage distribution of calories from carbohydrate, protein and fat for post-kwashiorkor (p-K) and post-marasmic (p-M) children not breastfed anymore in the various seasons 162

Table 6 – 1: Variables entered into the logistic regression in starting and final model corresponding to the dependant variables (OCH: Occurence of nutritional oedema in the index child) 171

Table 6 – 2: Classification table of the final model of index children with nutritional oedema 172

Table 6 – 3: Important determinants for the occurence of nutritional oedema in the index children, significance level, Exp (B) and 95% confidence interval (CI), determinants from the optimal model under those with the best prediction 173

LIST OF FIGURES

Figure 2 – 1: The aetiology of PEM, especially kwashiorkor 6

Figure 3 – 1: Study area 20

Figure 3 – 2: Beginning of the *kocho* preparation – removing the fleshy pseudostem 22

Figure 3 – 3: Fermentation pit 22

Figure 3 – 4: Fermentation pit covered with *ensete* leaves 22

Figure 3 – 5: *Kocho* preparation 22

Figure 3 – 6: Preparation of *kita*-maize bread 23

Figure 4 – 1: Absolute income (Birr) by season, households with ex-PEM children and controls 37

Figure 4 – 2: Sources of income (average % of entire income) during the seasons, households with ex-PEM children and controls 46

Figure 4 – 3: Mean food expenditures food expenditure (Birr) during the seasons for households with ex-PEM and control children 52

Figure 4 – 4: Share of food expenditures food expenditure for different foods in the pre-harvest season – non-oedematous group 63

Figure 4 – 5: Share of food expenditures food expenditure for different foods in the pre-harvest season –oedematous group 63

Figure 4 – 6: Share of food expenditures food expenditure for different foods in the coffee season – non-oedematous group 64

Figure 4 – 7: Share of food expenditures food expenditure for different foods in the coffee season – oedematous group 64

Figure 4 – 8: Share of food expenditures food expenditure for different foods in the postharvest season – non-oedematous group 65

Figure 4 – 9: Share of food expenditures food expenditure for different foods in the post-
harvest season – oedematous group 65

Figure 4 – 10: Part of households (in %) with harvest of different agricultural products during the seasons 72

Figure 4 – 11: Head of household’s self assessment of problems in daily life – pre-coffee season (%) 77

Figure 4 – 12: Head of household’s self assessment of problems in daily life – coffee season (%) 78

Figure 4 – 13: Caregiver’s self assessment of problems in daily life – pre-coffee season (%) 80

Figure 4 – 14: Caregiver’s self assessment of problems in daily life – coffee season (%) 80

Figure 4 – 15: Number of foods from own production throughout the seasons in households with ex-PEM children and controls 85

Figure 4 – 16: Number of foods bought at the market over the season in households with ex-PEM children and controls 85

Figure 4 – 17: Number of all foods available throughout the seasons in households with ex-PEM children and controls 85

Figure 4 – 18: Number of foods from own production throughout the seasons in households with oedematous and non-oedematous children 86

Figure 4 – 19: Number of foods bought at the market throughout the seasons in households with oedematous and non-oedematous children 86

Figure 4 – 20: Number of foods available throughout the seasons in households with oedematous and non-oedematous children 86

Figure 4 – 21: The association between care (terciles) and ex-PEM 105

Figure 4 – 22: The association between care (terciles) and the occurrence of nutritional oedema 106

Figure 5 – 1: Illness frequency (at least one disease) for post-marasmic and post-kwashiorkor children throughout the entire study year 123

Figure 5 – 2: Illness frequency (at least one disease) for post-marasmic and post-kwashiorkor children from January to June 123

Figure 5 – 3: Illness frequency (at least one disease) for post-marasmic and post-kwashiorkor children from July to December 124

Figure 5 – 4: Illness frequency (at least one disease) for other household members of post-marasmic and post-kwashiorkor children throughout the entire study period 124

Figure 5 – 5: Profile of weaning process 129

Figure 5 – 6: Types of weaning foods given to the children, ex-PEM children and controls 130

Figure 5 – 7: Adequacy of the diet (in %) of oedematous and non-oedematous children– mean for the entire study period 143

Figure 5 – 8: Energy intake (Kcal/d) according to the age of the oedematous (oedpat=1) and non-oedematous (oedpat=0) children 150

Figure 5 – 9: Percentage distribution of main nutrients 156

Figure 5 – 10: Percentage distribution of micro nutrients and vitamins 157

Figure 5 – 11: Contribution of calories and nutrients from different food groups to a typical diet of an *oedematous* child in the pre-coffee season 159

Figure 5 – 12: Contribution of calories and nutrients from different food groups to a typical diet of a *non-oedematous* child in the pre-coffee season 159

Figure 5 – 13: Mean of percentage distribution of calories from carbohydrate, protein and fat for non-oedematous and oedematous children not breastfed anymore in the various seasons 161

Figure 6 – 1: Scatter plot with local regression of the number of foods available in the pre-coffee season (nofoall3) depending on the per capita income (incpcap3) for households with non-oedematous and oedematous children 164

Figure 6 – 2: Scatter plot with local regression of the number of foods available in the coffee season (nofoall4) depending on the per capita income (incpcap4) for households with non-oedematous and oedematous children 165

Figure 6 – 3: Relationship between care index and adequacy rate of energy requirement 167

Figure 6 – 4: Relationship between care index and adequacy rate of fat requirement 167

Figure 6 – 5: Relationship between care index and adequacy rate of protein requirement 168

Figure 6 – 6: Probability of nutritional oedema (oedematous=1, non-oedematous=0) in the index child 175

Figure 7 – 1: The cyclical oxidation and reduction of glutathione is central to the mechanismus whereby the cell protects itself from the potential damaging effects of free radicals. The processes associated with the protection from the adverse effects of free radicals involve many specific nutrients that have been found to be deficient in severe malnutrition. 209

ANNEX CONTENTS

ANNEX A: TABLES

Annex A 4 – 1: Average per capita income, total expenditures, expenditures for food, food budget share for the groups during the seasons 277

Annex A 4 – 2: Frequency distribution of households with children according to clinical classification in hospital (kwashiorkor (K), marasmus (M), and Control (C)) in the tercile groups with respect to income, total expenditures and expenditures for food 278

Annex A 4 – 3: Frequency distribution of households with children according to classification after discharge from hospital (non-oedematous (NO), oedematous (O)) in the tercile groups with respect to income, total expenditures and expenditures for food 279

Annex A 4 – 4: Mean amount of Birr spent for different food during the seasons 280

Annex A 4 – 5: Agrigultural production (kg) of farmers during the seasons and usage pattern 281

Annex A 4 – 5: continued : Agrigultural production (kg) of farmers in the seasons and usage pattern 282

Annex A 4 – 6: Animal husbandry: households owning livestock, average number of livestock 283

Annex A 4 – 7: Products from livestock: households who had animals with production, mean number of product, usage pattern 284

Annex A 4 – 8: Variables included in the hygiene index and their relevance (expressed in significance level) to the occurrence of diarrhoea 284

Annex A 4 – 9: Scoring system for different child care practices and resources included in the various indices forming the care index for oedematous (O) and non-oedematous (NO) children 285

Annex A 4 – 9: continued :Scoring system for different child care practices and resources included in the various indices forming the care index for oedematous (O) and non-oedematous (NO) children 286

Annex A 5 – 1: Seasonal influences on the mean adequacy ratio for various nutrients of oedematous and non-oedematous children (trimmed mean for main nutrients, outlier for micronutrients: Fe, B1, B2, Vitamin C) 287

Annex A 5 – 2: Seasonal influences on the mean adequacy ratios for various nutrients of ex-kwashiorkor, ex-marasmic patients and controls (outlier removal or trimmed mean) 288

Annex A 5 – 2: continued: Seasonal influences on the mean adequacy ratios for various nutrients of ex kwashiorkor, ex-marasmic patients and controls (outlier removal or trimmed mean) 289

Annex A 5 – 3: Seasonal influences on the mean adequacy ratios for various nutrients of post-kwashiorkor and post-marasmic children 290

Annex A 5 – 4: Absolute daily intake of essential amino acids in non-oedematous and oedematous children in the seasons 291

Annex B: Questionaires and Observation Guide 293

Annex C: Example of a diet in the home of a child treated once for kwashiorkor 305

ABBREVIATIONS AND AGRONYMS

CI	Confidence interval
EFA	Essential fatty acid
FAO	Food and Agriculture Organisation of the United Nations
FER	Fat Energy Ratio
H/A	Height-for-age
IFPRI	International Food Policy Research Institute
NCHS	United States National Centre of Health and Statistics
NGO	non-government organisation
OR	Odds Ratio
P	Probability
P/E-ratio	Protein Energy Ratio
PEM	Protein-Energy Malnutrition
RDA	Recommended Daily Allowance
SD	Standard deviation
SPSS	Statistical Package for Social Sciences
UNICEF	United Nations Children ‘s Emergency Fund
W/A	Weight-for-age
W/H	Weight-for-height
WHO	World Health Organisation
Z-Score	Statistical unit comparable to SD
	= Individual´s value-median value of reference population
	SD-value of reference population

TERMS AND ABBREVIATIONS OF STUDY DATA

CAPCA	Fulfilment (%) of calcium requirement
BEHVINDX	Index of mothers' behaviour towards index child
Ca/P ratio	Calcium Phosphate Ratio
CHPCEN3	Contribution of carbohydrate calories to total calories (%) in the pre-coffee season from April to July.
EDUCINDX	Index of education of caregiver and head of household
ENERPCA	Fulfilment (%) of energy requirement
FATPCEN3	Contribution of fat calories to total calories (%) in the pre-coffee season from April to July
GSFRFAPO	Mean number of diseases in household members other than the index child with exception of nutritional oedema and symptoms accompanying oedema
GSFRPATO	Mean number of diseases in the index child with exception of nutritional oedema and symptoms accompanying oedema
HOINDX	Household organisation index
HYGINDX	Hygiene index
KNOWINDEX	Index of caregiver's knowledge of how to feed young children
INCPCAP	Per capita income
NOFOALL	Number of foods available
NIACPCA	Adequacy rate (in %) of niacine intake over the study year
NO	Non-oedematous
NOKIALLZ	Number of foods available in the household
O	Oedematous
OCH	Occurence of nutritional oedema in the index child of the total sample
OEDFAM	Oedematous children in the household
OEDPAT	Oedematous index children
p-K	Post-Kwahiorkor
p-M	Post-Marasmus
PRA	Participatory Rural Appraisal
PROBINDX	Index of perceived problems in the household
PROTPCA	Adequacy rate (in %) of protein intake over the study year

PROTPCAU	Adequacy rate (in %) of utilisable protein intake over the study year
SAAAU	Mean of absolute intake of sulphur-containing amino acids throughout the year
VITB1PCA	Fulfilment (in %) of thiamine requirement
VITB2PCA	Fulfilment (in %) of riboflavin requirement

1 INTRODUCTION

1.1 Subject

A nutritional research project about PEM (Protein-Energy Malnutrition) children was carried out in Yirga Alem Hospital, Southern Ethiopia. The on hand study was part of several studies carried out within the main project titled: "The Child With Severe Protein-Energy Malnutrition (kwashiorkor) And The Family". The title of this study is: "Socio-economic, environmental, care, health and nutritional determinants in the aetiology of severe protein-energy malnutrition in Southern Ethiopia (Sidama) with emphasis on kwashiorkor - A one year prospective and retrospective follow-up study to find out predisposing factors."

1.2 Facts, relevance of the research topic and hypotheses

In developing countries protein-energy malnutrition (PEM) is a widespread disease. Protein-energy malnutrition is by far the most lethal form of malnutrition and children are its most visible victims. According to the WHO (2002), malnutrition is an accomplice in at least half of the 10.9 million child deaths each year. These young lives are prematurely lost. First recognised in the 20th century, PEM's full impact has been revealed only in recent decades. Infants and young children are most susceptible to PEM's characteristic growth impairment because of their high energy and protein needs and their vulnerability to infection. Malnutrition enlarges the effect of every disease. PEM is most common in children aged 1-5 years, but it can also occur in older individuals. There are three main types of severe PEM, namely kwashiorkor marasmus and marasmic kwashiorkor, with very different appearances and clinical features. Kwashiorkor is more complex than marasmus. The main signs of marasmus are: extremely low weight, extreme wasting, an "old person's face", a "pot belly", iritability and fretfulness, hunger. The main signs of kwashiorkor are: oedema, moon face, wasted, weak muscles, misery and apathy, poor appetite, pale, thin, peeling skin; pale, sparse hair with week roots and enlarged liver. Marasmic kwashiorkor is a mixture of the other two (SAVAGE KING AND BURGESS 1992). Up to now, the aetiology of kwashiorkor is not fully understood. Several theories have tried to explain the occurrence of kwashiorkor: the classical theory of protein deficiency (WILLIAMS

1935), niacin deficiency (GILLMAN AND GILMAN 1951), antidiuretic-hormone-like action of free ferritin (SRIKANTIA 1958), dysadaptation to a protein deficient diet (GOPALAN 1968), hormonal dysadaptation to unbalanced protein-energy deficiency (WHITEHEAD 1979), or aflatoxin intoxication (HENDRICKSE *et al.* 1982). All the hypotheses do not adequately explain more than few of the features of kwashiorkor (GOLDEN 1985). The recent theory says that kwashiorkor results from an imbalance between the production of toxic free radicals and their safe disposal (GOLDEN 1985, LEICHSENRING 1995).

Among the factors that may increase free radicals are: infections, toxins (such as aflatoxin), sunlight, trauma and catalysts (such as iron). In healthy individuals, free radicals are destroyed or removed by the antioxidant function of vitamins A (or ß-carotene), C, and E, by coeruloplasmin and transferrin that bind free iron and facilitate its oxidation, and by zinc-metallothionein, which acts as a free radical sink. Enzymes in which glutathione and trace minerals play an important role, such as Cu-, Zn- and Mn- superoxide dismutase, and Se- glutathione peroxidase play an important role in the antioxidant system The toxic effects of free radicals could be responsible for cell damage leading to the alterations seen in kwashiorkor.

The following hypotheses can be postulated in the causal chain of kwashiorkor:

Children with nutritional oedema, compared to controls and to those with marasmus, have been more exposed to

A 1: noxae that generate oxidative stress, or/and to

A 2: factors that compromise defence against free radicals.

Regarding A 1 it has never been shown that children who develop kwashiorkor have been more often, longer or stronger exposed to infections than children who develop marasmus, although the pattern of infections may be different. Measles is often mentioned as precipitating kwashiorkor (COULTER 1988), particularly in Africa, whereas diarrhoeal disease is more prominent in marasmus (MURPHY 1966). It has not become clear yet whether this difference might have any relevance for free radical production.

Regarding A 2, there has not yet been evidence that diets of children with kwashiorkor are more deficient of factors that protect against free radical damage, such as ß-carotene, vitamin E, selenium or zinc. Moreover, it is not sufficiently examined whether the diet of kwashiorkor children differs in protein and energy from those with marasmus.

The nutrition, growth, and development of infants and young children depend not only on sufficient food, but also on adequate health services and appropriate caring behaviour (UNICEF 1990). Care means the provision of time, attention and support to meet the physical, mental, emotional and social needs. A household's capacity to provide care depends on the availability of resources (or the absence of constraints) within the household and wider community that can foster the translation of knowledge into appropriate care practices such as breast-feeding and complementary feeding, use of health care services, and good hygiene (IFPRI 2000). A lack of care for the child might be an important factor, for the development of kwashiorkor.

Many investigators recommend that the quality of home environment and the quality of the interaction between caregiver and child must be assessed through observational means, even if the observation is brief (HEFFER AND KELLEY 1994). In this study quantitative and qualitative aspects of child-care were assessed. An activity profile of caregiver and child was carried out. In addition, through intensive direct observations during the 24 hours stay of the study team, interactions between caregiver and child as well as between caregiver and a possible partner were observed and registered, aiming at characterising relevant features of the relationship between the observed persons.

In this context the following hypothesis can be postulated:

A3: Children with nutritional oedema, compared to controls and to those with marasmus, have been more exposed to a lack of care.

In the context of kwashiorkor it has been shown in several studies that social or emotional deprivation or both could be found to be significant in the background of children with kwashiorkor (GOODALL 1979). In this study care practices, behaviours and resources were put into relationship to other possible determinants for the development of kwashiorkor.

1.3 Objectives of the study

The main objectives of the present study were to examine:

1. **Socio-economic and environmental factors** of the investigated household (household size, occupation, income, expenses, agricultural production, sanitary situation etc.).

2. **"Caring capacity"** for the observed child (psycho-social and behavioural aspects of the interaction between caregiver and child, associated characteristics and the social network surrounding the dyad. Which of the caregiver and household characteristics constituted severe constraints to the provision of good child-care)?

3. **Physiological determinants** of growth, including height and weight of the child, morbidity of the index child and the household investigated.

4. **Composition of the diet of children with nutritional oedema compared to a control group**. Special interest: Were there any differences concerning anti-oxidant substances in the diet, such as sulphur-containing amino acids, ß-carotene, vitamin E etc.? Were there any differences concerning the main Nutrients: protein, fat and energy intake? Study of predisposing factors pertaining to food and nutrition e.g. hygiene, preparation of food, etc., which may be relevant in the aetiology of kwashiorkor.

5. **Nutritional knowledge** and **nutritional behaviour** of the caregiver.

6. The **most important determinants** for the development of kwashiorkor.

2 METHODOLOGY

2.1 Causal model

In 1990, UNICEF presented a conceptual framework for the analysis of nutrition security in which malnutrition is considered the outcome of nutrition insecurity. The author adopted this model (UNICEF 1990) for the development of kwashiorkor. Its different determinants were grouped on different causality levels. Thus, kwashiorkor is a result of immediate, underlying and basic causes (Figure 2–1).

Having the above mentioned hypotheses in mind, the conceptual framework for the development of kwashiorkor can be constituted as follows: Inadequate intake of nutrients, especially antioxidants, and a high occurence of diseases are immediate causes of malnutrition, especially kwashiorkor. These causes are again highly influenced by inadequate food availability and access to food (household food security), by inadequate childcare as well as insufficient health services and an unhealthy environment. Besides food availability and access to food the dietary intake implies the household's or individual's desire to obtain the available food and their knowledge of appropriate food preparation, composition and distribution among the household members. The occurence of diseases depends on different aspects of primary health care, such as immunisation, oral re-hydration, nutritional education as well as environmental conditions such as contamination (water, food), housing conditions, hygiene practices, and food preparation.

Care can be provided by the household or the community and includes care for the child in general, such as child feeding and protection from infection as well as care for the sick child (RAMAKRISHNAN 1995). Inadequate childcare practices can be important determinants for the development of kwashiorkor.

The underlying causes are again influenced by the basic causes, the human, socio-economic, organisational resources and the control over these resources. Inadequate education, especially nutritional knowledge, inadequate income and/or use of income, too many dependants, a difficult family situation (marital status, death of family member, no occupation etc.) and the socio-cultural behaviour are further contributing factors to malnutrition/kwashiorkor.

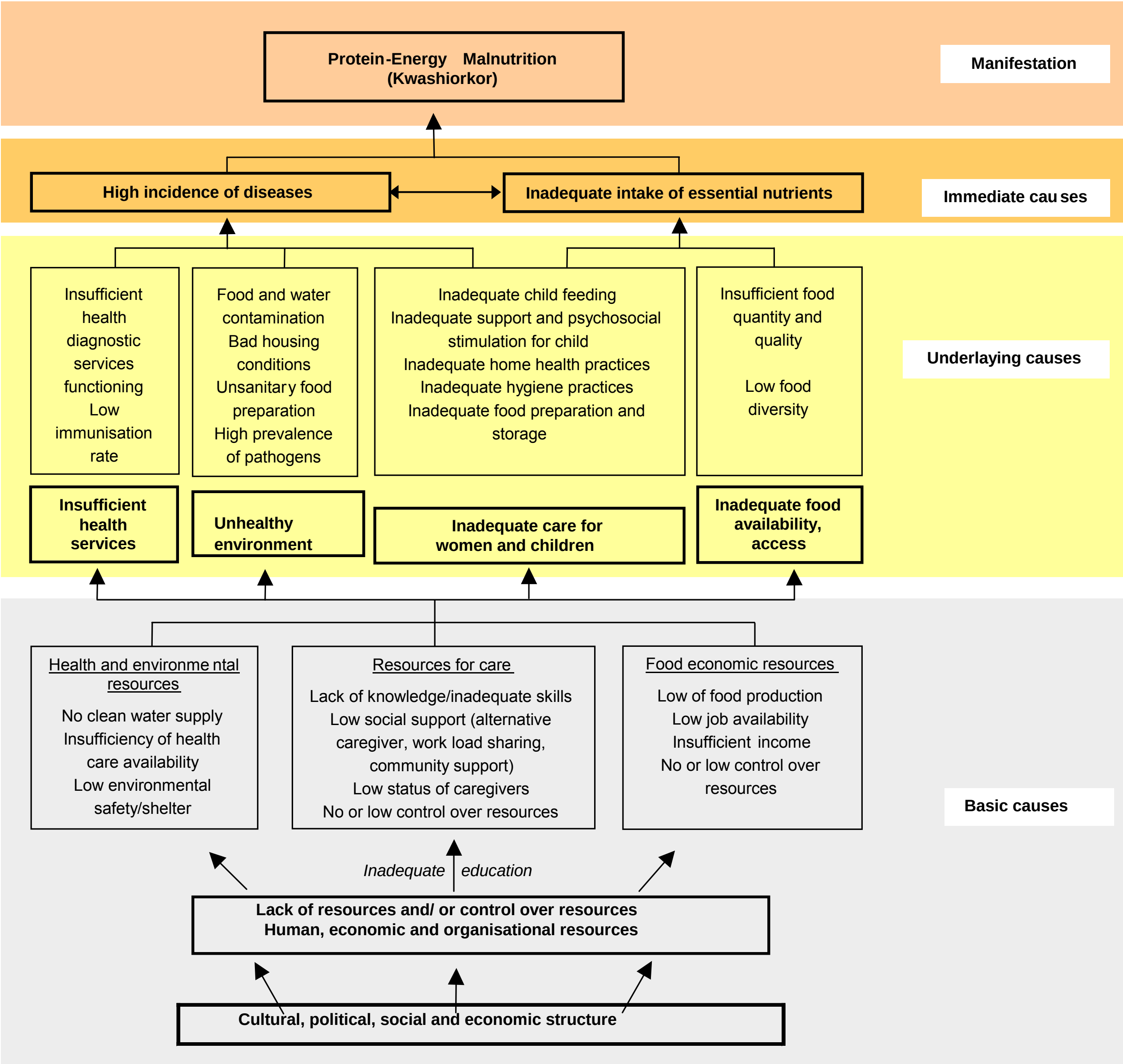

Figure 2 – 1: The aetiology of PEM, especially kwashiorkor

2.2 Study design

The present study is a case – control study which was carried out between June 1996 and March 1998. The sample was composed out of kwashiorkor and marasmic patients who were admitted to Yirga Alem Hospital between the time period of 1996 and 1997 and control children.
During the admission of their child to hospital, parents of the patients were brought to their homes by the project staff, where the project staff was introduced to the rest of the household. The intention was to find the houses of the former patients at the follow-up visits and to build a confiding relationship to the families. At the same time for comparison, control households and children were selected in the direct neighbourhood of the patient’s home. In order to minimise selection bias, thus to get households living under most similar preconditions as patients' households, the nearest home to the patient's house was investigated for potential control households. In case this family did not agree to be included, failed to fulfil the criteria mentioned below, or did not have children below the age of 5, the search for another family was continued in the same direction. The following criteria were used for inclusion in the control group: 1.) absence of nutritional disease history in all children of the family regardless of their age; 2.) weight-for-age ≥ 80% of the reference median of all children younger than 7 years of age; 3.) absence of any symptoms suggestive of PEM or other nutritional disease in all children of the family. 4.) the control child should be similar in age and sex of the index child. Starting the study it was recognised that in this area it was nearly impossible to find households in the neighbourhood where none of the children were underweight. Finally, the absence of nutritional oedema and marasmus at time of selection and in the past history of the control children and their siblings was applied as the criterion for a control child. Even so, it was not possible to find more control children, what points to the fact that PEM is a big problem in this region. Anyway, the number of controls seems to be reasonably large enough to analyse the situation and to make recommendations for improvements.

After the patients had been treated in hospital, they were discharged and the follow-up period started. The time period of the follow-up was between April 1997 and March 1998. During this time all the households were visited 3 times, every 4th month according to the seasonal changes during the year. Following discussions with local experts, the year was separated into **three seasons**:

- the pre-harvest season from April to July,
- the coffee-harvest season between August and November, and finally
- the post-coffee season between December and March.

In addition, the year was separated into three study periods according to the capacity of the project staff and the feasibility to perform the home visits. Three women, all of them familiar with the local language "Sidaminia" and the symptoms of malnutrition, were doing the follow-up visits during this time. The project staff used the same means of transportation like the local population: local taxis and walking. It has to be borne in mind that some of the villages were located in very remote areas and especially during the rainy season it was very hard to reach some of the households. Since some of the families moved or were not around at the time of the follow-up visit, the sample size of the study was reduced to only those households who were visited in all three study periods. Finally, 106 households were included in the analysis even though more households were visited during the follow-up period. During the home visits families were getting basic health and nutritional advice. If a family member happened to be ill, admission to the hospital was facilitated.

Study planning and data assessment was discussed and co-ordinated with the project-staff and local district health service members. A one week training of the field workers in interviewing, anthropometry and weighing of food was carried out by the author of the study. A pre-test of the questionnaire and the observation guide was arranged in other households than the actual sample, but in the same region. The interviews were carried out with the head of the household, in most cases the father or step-father of the index-child and the caregiver of the child. The word caregiver as used in this study denotes the people who look after infants and young children (WHO 2004). The term caregiver is preferred because some of the children were not looked after by their biological mothers.
In case the household was headed by a woman, she answered the questions concerning the head of household as well as the questions concerning the caregiver and the child.

All the interviewers could speek in addition to the local language "Sidaminia" English, so that it was no problem for them to fill the questionnaires as well as to write down notes and communicate with the main investigator.
Determinants were analysed according:

- to the clinical classification as categorised at the time of hospital admission: **ex-kwashiorkor, ex-marasmus and controls**. Weight and height was measured on admission and related to the NCHS standards. The kwashiorkor group was not solely defined according to the Wellcome Classification (WELCOME TRUST WORKING PARTY 1970) but comprised only children with the ful clinical picture of the syndrome (60-80% weight-for-age, generalized oedema, discoloration, partial loss of hair, typical skin lesions). The group of marasmic children was defined by the Wellcome classification (< 60% weight-for-age and no oedema). The information for these groups was collected retrospectively. Children admitted with marasmic-kwashiorkor were excluded since determinants for the development of kwashiorkor should be analysed and differences between marasmus and kwashiorkor should be emerged.

- to the classification of **oedematous and non-oedematous children** after discharge from the Yirga Alem Hospital. The former PEM-children treated in hospital as well as the controls were classified according to the occurrence of oedema, no matter which grade of the oedema, during the follow-up period in order to obtain prospective information about the determinants for the development of malnutrition, especially kwashiorkor. In some calculations, concerning the family, also the siblings of the index child who had nutritional oedema were included.

- to **post-kwashiorkor and post-marasmic children**. To show differences between kwashiorkor and marasmic children, all those children who became oedematous after discharge from hospital and were not marasmic at the same time were compared to marasmic children, who had <60% of the mean weight-for-age at the time of the follow-up study. Since the sample of this group was rather small, analysis was only carried out for nutritional, health and care aspects.

2.3 Variables, indicators and methods

Considering the multi-causality of determinants for the development of malnutrition /kwashiorkor (see 1.4.1), it is unlikely that one indicator alone may provide sufficient information. Resulting from the causal model, the following variables and indicators were selected as adequate in this study.

Table 2 -1 : Variables, indicators and methods applied in the present study

No.	Causality level	Variable	Indicator	Method
1	**Manifestation**	**Nutritional status**		
		-kwashiorkor	Clinical picture of the syndrome 60%-80% of weight-for-age, generalised oedema, Discoloration of the skin, partial loss of hair, typical skin lesions	Anthropometric measurement, physical examination
		-marasmus	<60% of weight-for-age, no oedema	Anthropometric measurement
2	**Immediate**	**Diseases**	Occurence of diseases for the index child and other household members members	Questionnaire, PRA
			Number of diseases in a period of time - index child - other household members	Questionnaire
3		**Dietary intake**	Amount of nutrient intake during one day	Individual food weighing Observation
			Food consumption pattern	Food frequency
4	**Underlying**	**Caring capacity, carying practices**	Cleaning the child	Observation PRA*
			Occupation with the child	Observation PRA
			Start of weaning	
			Different foods given to child etc.	
5		**Household food security**	Agricultural production	Questionnaire
			Animal husbandry	
			Food shortage	
6	**Basic**	**Knowledge about child feeding**	Child feeding of index child	Questionnaire Observation
7		**Socio-econ., environmental factors**	Size of household, water sources, income, expenditures, source of income etc.	Questionnaire Observation
8		**Resources of care**	Time for care of child etc.	Questionnaire Observation

* PRA: Participatory Rural Appraisal

Quantitative data were complemented by qualitative data. A *standardised questionnaire* was used for the collection of information on the household level (family) as well as on the individual level (caregiver, index child). The following aspects were recorded:

- household size
- educational level
- income, sources of income
- expenditures, total and on food
- agricultural production and use of it
- food shortage
- sanitation and drinking water availability
- access to health services
- immunisation rate
- occurence of diseases
- food-consumption of the index child
- nutritional knowledge of caregiver
- self assessment of daily problems

At each home visit children were checked for nutritional oedema. In addition, anthropometric data was taken, including weight and height of the index children. A tape measure was used to measure the body height of children older than two years. For children under two years a length board ("baby board") as described by GIBSON (1990) was used. In those cases the measurement of the home visits of a parallel running study (belonging to the same project) - where a car was used to visit the households - were taken, since it was impossible for the three field workers to carry such a board by walking to the remote areas. The interval between the two different home visits was 2 months at the most. To measure body weight of the children SALTER spring balance scales (max. 25 kg) with weighing pants and an accuracy to 0.1 kg was used. The exact birth date of the children was registered at hospital admission or, in case of the control children, at the first home visit. Since in many families there was no birth certificate, family book or growth/vaccination card available, the birth date of the child was obtained by asking the household members or neighbours at which local event, harvest etc. the child was born. Thus, a bias of the exact birth date of some of the children could not be avoided.

For assessing the food consumption pattern and the food intake of the index children a combination of food frequency and exact weighing of food, was combined to get a higher accuracy of the information (HARTOG 1995). The most important foods to be included in the lists for the food frequency assessment were determined according to information from market observation, informal assessment and from discussions with key persons familiar with the food in this area. The food weighing was done with SOEHNLE digital food weighing scales with tara function for food weighing up to 2.000 g. For foods more than 2 kg spring scales were used (max.12 kg) with an accuracy to 0.1 kg. “The problem with assessing diet intake in individuals is that if you assess it, you change it” (HALLFRISCH 1994). In this study biasing meal composition through presence of the project staff during the meals as well as weighing- and converting biases and possible uncommon meals was considered to be low. All families were familiar with the project staff. Through the long stays in the houses of the families - each time 24 hours with an over night stay - the families were treating the project staff as “one of them”. All field workers were familiar with the local language which was very important for the acceptance. Food and blanket for the night needed by the field staff for the home visits were brought by themselves not to bother the families.

Normally, the FAO method (FAO 1962) covers seven days for the assessment of food intake, but the number of days to assess depends mainly on the inter-day and inter-household variation. “Where the diet is extremely simple, a shorter time period may give equally valid results” (CHAVEZ and HUENEMANN 1984). Observation and discussion with key persons showed very little inter-day variations. Menu composition changes remarkably from “normal” only on religious holidays, or at traditional celebrations (weddings, funerals etc.). Negligible or no difference was found on market days or Sundays.

According to PAUL and SOUTHGATE (1988), the calculation of nutrient intake involves both types and amounts of foods eaten, multiplied by the composition of the food. Energy provided by fat and protein was calculated with 9 kcal per g fat and 4 kcal per g protein. The Food Composition Table for Use in Ethiopia I (1968) and II

(1975) was used for calculation of the nutrient intake of the children. Some foods not presented there were taken from the Souci Fachmann Kraut. Recommended Dietary Allowances (RDA) (RDA 1989) and the Dietary Reference Intakes (DRI) (DRI 1997) were used to calculate the fulfilment of requirements. In order to have an idea about the intake of amino acids estimates of amino acid requirements in pre-school and school-children from the FAO/WHO/UNO (FAO/WHO/UNO 1985) were applied.

Different *qualitative assessment methods of Participatory Rural Appraisal* (PRA) (CHAMBERS 1991, CHAMBERS 1992), such as structured and informal interviews, seasonal mapping of agricultural calendar, diseases etc. as well as participant observations were applied to complete and support data gathered by quantitative assessment procedures.

Qualitative assessment methods were specially used for the assessment of the activity profile of caregiver and index child, of caring practices and resources, of behaviour pattern, food preparation and the self-estimation of problems causing kwashiorkor. Results from participant observation were noted in an observation guide (Annex B p. 295) or noted and discussed with key persons for further interpretation. After each field visit, which lasted 4 days at the most, the field workers came back to the Yirga Alem Hospital where all questionnaires were checked and observations were discussed with the main investigator.

2.4 Data analysis and statistics

Since several methods of data analyses according to the complex parts of research fields (social, economic, care, health and nutritional background of kwashiorkor) were applied in this study the different methods are explained in detail in the corresponding chapters. In this chapter the methods applied are explained in general.

For data entry of anthropometrical data EPI-NUT, one part of the EPI-INFO programme -Version 6.0- was applied, which calculated the anthropometrical indices according to the internationally accepted classification. All children below the cut-off point of –2SD (standard deviation) were considered to have a low anthropometric status, compared to the WHO recommended NCHS (National Centre of Health and

Statistics) reference population (WHO 1986). NUTRISURVEY was used to enter data of nutrient intake of the index children and to perform the analysis. Further data entry and statistical analysis as well as some graphics were carried out with SPSS for Windows Version 10.0 and 11.0.

For univariate descriptive analyses of nominally or ordinary scaled variables frequency counts were given, whereas for interval scaled (metric) variables the arithmetic mean and the standard deviation were computed, in cases of suspected non-normality also the median.

Some of the metric variables were discretized by dividing them into groups according to the terciles (i.e. the values below respectively above which one third of the sample values lie). For particular kinds of observations (e.g. different aspects of the behaviour of the caregiver) indices were formed by adding assigned scores. Detailed descriptions for score building are contained in the special chapters and the Annex. In order to test dependencies between nominal, ordinal or discretised metric variables Pearson's chi square test or Fisher's exact test were used. In the case of two dependent samples also Mc Nemar's test was applied. From crosstabulations also odds ratios were calculated in order to assess risk factors for oedema.

To compare means of metric variables (data) between two groups, the t-test was used in case of normality of data within the groups, otherwise the median test or the Mann Whitney test was used. The Kolmogorov Smirnov Silliefors test and the Shapiro Wilk test were used to determine normality. When normality was impaired only by a few outlying values, these were excluded from the analysis and the t-test was repeated. In case of non-normality the detrended q-q plots of the SPSS exploratory data analysis were examined to decide if the deviations from normality are similar in the two groups so that the Mann Whitney test could be applied.

When the means of more than two groups were compared, the analysis of variance with additional post hoc tests was used in case of normality of the residuals. In case of non-normality the median test was applied first to test overall differences, and pair wise comparisons of the groups were performed also with the median test. The results of the pairwise comparisons were corrected with Shaffer's procedure in order to guarantee the overall significance level (SHAFFER 1986). This method corrects only significances of pairwise tests resulting from a partition of the sample into more than

two groups. There is no feasible method to correct for underestimating significances arising from tests of some dependent variable with respect to several partitions.
To compare means of the same measure (e.g. crop amounts) between different seasons, the t-test was used in case of normality of the differences. Otherwise the sign test was usually applied, but when the distributions of the measures in the different seasons were similar, except differences of medians, the Wilcoxon rank sum test was used. When the measures are compared between more than two seasons, the Shaffer correction was applied.

To assess the connection between ordinal or metric variables, Spearman's rank correlation was computed and tested.

In order to find the determining factors for the occurrence of nutritional oedema, a stepwise backwards logistic regression was performed. The independent variables (predictors) were pre-selected on the basis of their Spearman correlation with the occurrence of oedema. Odds ratios and risk classes were formed according to the results of the final model in the logistic regression.

The significances p (error probabilities of the null hypotheses) given by the SPSS program were classified as weakly significant if $p < 0.10$: (*), significant, if $p < 0.05$: *, highly significant if $p < 0.01$: ** and very highly significant if $p < 0.001$:***.

Normally, the measurements of income, nutrition etc. were compared between the investigated groups and the seasons. The results were tabulated and the significances of differences were marked by asterisks or shading.

Word for Windows 2000 was applied for text and Tables. Excel was used for some Tables and graphics respectively. Also SPSS was used for some graphics.
The source of the data for all Tables and Figures in this study is the own survey unless the source is cited differently.

2.5 Limitation of the study

The generalisation of the results, especially of the significances, is impaired by the fact that only one region around one hospital was assessed in one time period. The validity of the results could be improved by repeating the study in other locations at different times. To improve the validity of the study a combination of quantitative and qualitative methods was used.

The sample size of 106 children seems to be reasonably large enough to analyse the determinants investigated and to propose recommendations. The relatively small amount of the control children could not be increased because of the general problem to find control children in the direct neighbourhood of the index children. In comparence to the number of kwashiorkor children the numer of marasmic children was quite low, since during the time of the study more children with kwashiorkor were admitted. Even though the group was big enough to make conclusions concerning the differences in the determinants for the development of kwashiorkor and marasmus.

It has to be born in mind, that caregivers who brought their child to hospital for treatment were more dynamic than those who didn't take the intiative to bring their child to hospital. Reasons for that might be costs for the transport or for medicine but also neglectance.

Although the interviewers were not informed about the specific hypotheses to be tested, it can not be completely excluded that they had their own explanations concerning the derterminants for the development of kwashiorkor. A recall bias cannot totally be excluded, especially for questions concerning the memory of prior events (such as diseases), experiences or activities.

2.6 Ethical consideration

All problems in society have, aside from scientific aspects, also an ethical aspect, which is important to consider when research is carried out, thus research should not only be goal-or duty based, but should also take human rights into consideration (JONSSON 1995). The kwashiorkor project, jointly carried out between the Heidelberg Children's Hospital and the Yirga Alem Hospital, had been approved by the Ethical Committee of the University of Heidelberg. The studies on protein-energy malnutrition were approved by the Sidama Health Authorities, Awassa and the medical board of the Hospital. All survey participants were informed about the aim of the project and the assessment procedures. They were also told that all data would be used for the research objective only and would not be distributed elsewhere. Whenever the participants were discovered to have any health problems, admission to Yirga Alem was advised and facilitated by the project staff. Whenever a home visit was conducted, basic health and nutritional education was provided.

3 GENERAL CHARACTERISTICS OF THE STUDY AREA AND STUDY SAMPLE

3.1 Study area and population

The study took place in the Sidama zone in Ethiopia. Within the highland regions rural densities are highest in the areas of *ensete* (*Ensete ventricosum*) cultivation in southern Ethiopia. (HAILEMARIAM and KLOOS 1993). The Sidama zone is one of the most densely populated areas in Ethiopia. The size of the Sidama zone was estimated to be 10.000 km² and the population about 3.5 Mil. (IRISH AID 1998). The population density for this zone is compared to other zones of the country very high but exact data doesn't exist. But in an earlier study (SELINUS *et al.* 1971) the population density was already supposed to be about 200/km². The highest part of the population belongs to rural areas. The ethnic composition of the population in the study area is dominantly Sidama. However there are areas partly inhabited by people of Welaita, Amhara and Oromo origin. Most people in this zone are farmers, depending on what they grow to satisfy food needs of the household. The size of their land is very small, mostly less than 0.5 hectare. This is mainly attributed to the population pressure, particularly the demand for coffee land. The main crop grown in this area is coffee, which can generate cash that can ensure adequate purchases of basic food and other things, *Ensete ventricosum* and maize. Livestock also plays a role in contributing either by supplementing family food with animal protein or by ensuring cash needs. In the pre-revolution era the land in this zone served as a source of prosperity for the landlords who used to own most of the coffee farms. Moreover, the long tradition of cultivating *ensete* has been attracting many people to this area since *ensete* is considered a reliable source of food for farm families even under drought conditions (ABAGODU 1988)

Figure 3 – 1 : Study area

3.2 Food pattern in the Sidama zone

Dietary studies in the four major agricultural ecosystems of Ethiopia (grain cropping, *ensete*, cash cropping, and pastoralism) revealed considerable variations in the contribution of calories and nutrients from different food groups. In the Sidama zone most of the people are dependant on what they produce on their farm. The farm is more like a garden. In the middle of it a (mostly round) hut is built. An open grazing place is located in front of the hut (see Annex Photodocumentation). Mostly the cow(s) or other smaller animals are grazing there. Since the space is limited, farmers with many cattle let them graze in another place away from the own farm. The *ensete* plants together with coffee and other plants are grown beside and behind the hut. *Ensete ventricosum* is an important crop in parts of highland Ethiopia, especially in the Gurage and Sidama zones and has been grown there most probably thousands of years (SMEDS 1963). It has been estimated that 7 to 8 million people in the south and south western part of Ethiopia depend on fermented starchy staples prepared from *ensete* (FAO 1985b).

In Sidama, *ensete* is grown together with coffee. The starch extracted from the base of the pseudostem, which is made of a system of tightly clasping leaf bases or leaf sheaths. The pseudostem (Figure 3-2), which may be two to three meters tall, and young inflorescence stalk is a staple human food. Cultivation of *ensete*, is limited to Ethiopia, where it is a staple food crop of the people of the southern highlands. It resembles a banana plant and is often called "false banana". It does not produce an edible fruit. It needs about 4 to 5 years until the flowers are carried. The plant is mostly harvested before flowering, or the flowers are taken away. The starchy portions of the swollen pseudostem and the underground corm are edible. The plowing and manuring throughout the year are important cultivation activities. The husbandry of *ensete* and preparation of foods derived from the plant requires several complicated and strenuous procedures which are assigned to specific members of the family according to their age and sex. The starting of new shoots and transplantation is initiated by the male head of household. Cultivation, manuring and digging of the fermentation pits is done by juvenile males. The harvesting time and plant selection for harvest are controlled by the head of household. The harvest of the *ensete* begins at the end of October and continues until January. The younger women in the household remove the fleshy pseudostem (stalk or base) and leaf midribs for the strenuous task of extracting the pulp. The underground fermentation vessels are arranged, periodically checked and stirred, then declared finished under the supervision of the female head of the household (SHANK 1994). Figure 3-2 to 3-5 describe some steps of the *kocho* preparation, the major part of the product of the *ensete* plant.

Figure 3 – 2: Beginning of the *kocho* preparation - removing the fleshy pseudostem

Figure 3 – 3: Fermentation pit

Figure 3 – 4: Fermentation pit covered with *ensete* leaves

Figure 3 – 5: *Kocho* preparation

One study in the nearby Gurage region reported that one household handles about 46 *ensete* plants throughout the year with an estimated yield of 34 kg food per plant (PIJLS *et al.* 1995). The *kocho* is placed in a silo (Figure 3-4) which is lined with fresh *ensete* leaves. After the mixture is pressed down by trampling, it is covered with *ensete* leaves and stones and left to ferment. The *ensete* is ready to be used after 2-4 months but can also be kept for one year or longer. Several other parts of the *ensete* are highly preferred, such as *hamicho*, the rooty part, and *bulla*, which is the most refined (least fibrous) and palatable food made from *ensete*. The long time fermented *ensete* is a prestige food kept for feasts and ceremonials. Fresh *ensete* is not appreciated, but if one is short in the fermented type, a small amount of fermented *ensete* can be mixed with the unfermented in order to give the desired taste (SELINUS *et al.*1971). To prepare different foods out of the *kocho*, an amount of fermented pulp is taken out of the silo and prepared in corresponding ways. The *kocho* is mostly baked on the oven, *mitad* (Figure 3-6), on low heat (about 1 minute) to a thin bread, which is rolled and left to dry on the mitad for a few minutes. The nutritional value of the various foods do not substantially differ (PIJLS *et al.* 1995). About 97% of the energy present as carbohydrate, thus the protein content as well as the fat content is very low. Surveys reveal that in Ethiopia 65% to 80% of calories are derived from carbohydrates, 10% to 15% from protein, and 15% to 20% from fat (WOLDE-GABRIEL 1988). The dietary investigation of a study in the Gurage zone , where also ensete is planted, reported that the proportion of total energy intake derived from carbohydrate, protein and fat was 82%, 11% and 7%, respectively. The average consumption of *ensete* foods was 0.55 kg per day, providing 78% of total carbohydrate intake but only 20% of total protein intake (PIJLS *et al.* 1995).

Kocho and maize *kita* (Figure 3-6), a bread made out of maize flour and water, are the main starch staples for the families in the Sidama zone.

Figure 3 – 6 : Preparation of " kita"- maize bread

Both are eaten mostly together with *kale*, the local cabbage, called also *gomen*. It is consumed along with *ensete* and is the most important relish for most households. It is quite rich in vitamin A and C, iron, and to some extent, in protein. *Gomen* has a protein content of 4% compared to a protein content of 1% in *ensete*. In the *ensete* zone, 75% or more of calories and other nutrients, except fat, derive from *ensete* and *kale*. *Kale* is the main source of protein in this zone (BEKELE *et al.* 1993). The percentage of animal protein within the total protein consumption is reportedly low in all areas. In Sidama, milk and milk products are the main supplementary relishes for many farmers, beside cabbage (ABAGODU 1998).

Although Ethiopia ranks first in Africa and tenth in the world in its livestock population (UNCTAD/ICC 2000), the amount of meat consumed is very small. This is due to the fact that cattle, the most numerous livestock, are considered as a sign of prestige among pastoralists and are used by farmers for ploughing rather than as a source of protein. Milk production is similarly low because of low yielding breeds, lack of grazing and forage and inadequate veterinary services (BEKELE *et al.* 1993). Sidama cattle give, compared to Euro-American standards, a poor supply of milk. In the dry season it decreases to nil. But even in the rainy season it rarely exceeds 1 litre daily for each cow. The milk is usually not consumed in its natural state, but is churned to butter or produced to butter milk. Butter is not only used in the diet. Large quantities are used for cosmetics or decoration, but also for medical and ritual purposes. The multipurpose of butter makes it an important, scarce commodity, which to a certain extent functions as money. It can be hoarded and kept for years without spoiling, at least in the opinion of the Sidama (BROGGER 1986).

Other foods eaten in Sidama are *godere*, *boyna* (some types of potatoes) and red kidney beans. Biside bananas, another important fruit planted in Sidama is the avocado. The more subtropical rather than tropical varieties of avocado have a higher oil content (largely monounsaturated), with a valuable 124 calories per 100 grams. In addition, avocados have up to 4% protein. Avocados have the highest potassium content of any common domestic fruit (at about 600mg/100gms). While most meats are as high in potassium as fruit, they are accompanied by more sodium (and we add far more in cooking). In hunter gatherer (natural) times, potassium to sodium ratios were skewed very much more toward high potassium and low sodium than our standard Western urban 'diet'. High potassium fruits help partially restore the evolutionary balance, and avocados are top performers in the potassium stakes. While avocados are only a fairly good source of vitamin C, they are rich in many vitamins; avocados have appreciable levels of the B vitamin thiamine (about the same as lamb muscle meat, and better than beef muscle meat.); they also have useful levels of riboflavin (B2), with half an avocado providing about 6% of an adults recommended minimum daily intake. Half an avocado also supplies about 10% of an adults recommended minimum intake of Niacin (B3), and about 15% of an adults daily pantothenic acid (B5) and pyridoxine (B6) needs. Half an avocado also has around 600 International Units of vitamin A - quite a useful amount (http://www.naturalhub.com 2001).

Coffee is in this zone the most common beverage. According to interviews and observations, poor households use also the coffee peel instead of the beans. Coffee leaves are often used for tea. While drinking coffee often roasted maize corn, *kolo*, is eaten. *Tella*, the local beer is made out of barley and maize and is fermented for 7 days.

3.3 Protein-energy malnutrition - a major problem in the Saidama zone

In the Sidama zone protein-energy malnutrition is a major problem. The Yirga Alem Hospital was the biggest hospital in southern Ethiopia at the time of the study. In the year 1996, 7.9% out of 1050 patients admitted to the paediatric ward in Yirga Alem Hospital were admitted with kwashiorkor, 8.7% with marasmus, which means that 17% of all patients admitted were severely malnourished (data from Yirga Alem Hospital 1998). The experiences during this study show that nearly all neighbours' children of the patients' families under five years of age were underweight. During the survey it was hard to find any children less than five years who had a Weight-for-Age index over 80% of the reference standard (NCHS).

3.4 General nutritional structure of the sample

The nutritional status of the index children as well as the occurrence of nutritional oedema in the sample after discharge from hospital will be described in the following chapters.

3.4.1 Nutritional status of the index children

3.4.1.1 Methods

Anthropometric data was processed using the EPI-NUT programme, which is an integral part of the EPI-INFO version 5.1, which calculated children's weight for age (W/A), height for age (H/A) and weight for height (W/H) compared to the NCHS reference population. The nutritional status of the children was determined using the NCHS reference values as recommended by the WHO (WHO 1986). Underweight was defined as WAZ-scores >2SDs below the corresponding NCHS reference median (ie, WAZ<-2); wasting, WHZ-scores >2SDs below the corresponding NCHS reference median (ie, WHZ<-2) and stunting, H/AZ-scores >2SDs below the corresponding NCHS reference median (ie, HAZ<-2). Different degrees of malnutrition were classified as follows:

Normal:	≥ -2 z-score	(normal nutrition)
1 degree:	-2 to –3 z-score	(mild malnutrition)
2.degree:	-3 to –4 z-score	(moderate malnutrition)
3.degree:	< - 4 z-score	(severe malnutrition)

For **body-weight** measurements spring balance scales (max. 25 kg) with weighing pants were used. A correction of the weight was made subtracting the estimated weight of the clothes as 100 g. The **body-height** measurements of children under the age of two years were taken from a specially constructed length board (accuracy 0.1 cm). The other children were measured by a tape measure.

In some households it was difficult to get accurate **ages** of the children. Were neither birth certificates nor family books or growth/vaccinations cards were available, the specification of the date of birth was investigated by comparing the birth of the child to possible traditional ceremonies at that time, local events, seasons, harvest time etc. These uncertainties have to be taken into consideration when interpreting the H/A and W/A indicators.

3.4.1.2 Results

In this Chapter the results of the anthropometrical measurements of the last home visit are presented.

Results in Table 3-1 and Table 3-2 reveal that all children from the sample show an extremely high prevalence of stunting. Stunting is the outcome of failure to receive adequate nutrition over an extended period (chronic malnutrition) and is also affected by recurrent or chronic illness. The 2000 National Demographic and Health Survey (Central Statistical Authority Ethiopia and ORC Macro 2001) shows that 51 % of Ethiopian children under five years of age are stunted.

Especially the ex- PEM children had on average a mean of H/A z-score below –4 and even more than 50% of the control children were stunted. It shows that the chronic malnutrition is a huge problem in the Sidama zone. The data reflect the poor nutritional situation of children in Ethiopia. It is not only the high prevalence of stunting, but also the severity of malnutrition, which reflects a long-term inadequacy in energy and protein intake. Inadequate energy intake reduces the utilisation of protein in the diet and frequent infections impose an added requirement during the recovery phase. 10% of the control children, 50% of the ex-kwashiorkor and 61% of the ex-marasmic children were below the -4 HAZ. The degree of H/A z-scores between the groups was different to a significantly higher extent (p=0.000). As the W/A represents a composite measure of both wasting and stunting, (JELLIFFE, JELLIFFE 1989), the high prevalence of stunting is also reflected in a high prevalence of children having a low WAZ indicator (WAZ<-2). As expected, most of the children with a WAZ<-2 were marasmic children. The differences between the groups were highly significant (p=0.000).

Children belonging to the oedematous group had a lower mean z-score for W/A, H/A and W/H indicators of the NCHS standard compared to the non-oedematous group. Also, in the oedematous group the stunting figures were tremendously high. 57% of the oedematous children had a HAZ below –4 compared to 34% in the non-oedematous group. The high percentage of severe stunting indicates a much higher risk of morbidity (WHO 1995) and mortality (PELLETIER *et al.* 1995). In this sample there was a significant correlation between the H/A z-score and the number of illnesses the children were suffering from during the study year (r=-0.211, p=0.031). Also, the W/A z-score was significantly correlated with the occurence of diseases (r=-0.231, p=0.018) and the W/H z-score was weakly significant (r=-0.190, p=0.053).

At the end of the study the mean W/H z-score, showing the prevalence of acute malnutrition, of all children was in the normal range. In the background of the development of kwashiorkor, Table 3-2 reveals that wasting was found in about 30% of the oedematous and the ex-marasmic children (W/H z-score between –2 and –3), corresponding to mild forms of acute malnutrition.

Table 3 – 1: Nutritional status according to clinical classification of ex-patients (in %)

Nutritional status	WAZ			HAZ			WHZ		
	Groups*			Groups			Groups		
	C	K	M	C	K	M	C	K	M
Normal	60.0	17.9	11.1	46.7	10.7	5.6	96.7	80.4	66.7
1 degree malnutrition	26.7	32.1	16.7	26.7	17.9	5.6	3.3	17.9	27.8
2 degree malnutrition	13.3	32.1	33.3	16.7	21.4	27.8	-	1.8	5.6
3 degree malnutrition	-	17.9	38.9	10.0	50.0	61.1	-	-	-
Significance level P=	0.000			0.000			0.093		
Mean z-score (SD)	-1.77 (1.18)	-2.99 (1.10)	-3.58 (1.44)	-2.31 (1.69)	-4.11 (1.76)	-4.82 (2.41)	-.53 (0.94) (1.13)	-.68	-1.47 (2.31)

C:Control; K:Kwashiorkor; M:Marasmus

Table 3 – 2: Nutritional status according to classification of non-oedematous (NO) and oedematous (O) children (in %) after discharge from hospital

Nutritional status	**WAZ**		**HAZ**		**WHZ**	
	Groups		Groups		Groups	
	NO	O	NO	O	NO	O
Normal	31.6	21.4	23.7	10.7	86.8	71.4
1 degree malnutrition	30.3	21.4	19.7	14.3	10.5	28.6
2 degree malnutrition	25.0	32.1	22.4	17.9	2.6	-
3 degree malnutrition	13.2	25.0	34.2	57.1	-	-
Significance level P=	n.s.				0.059	
Mean z-score (SD)	-2.60 (1.34)	-3.14 (1.28)	-3.48 (2.07)	-4.35 (1.98)	-0.63 (2.05)	-1.17 (1.07)

n.s = not significant

Figures of **sex specific nutritional status** in oedematous and non-oedematous children show a statistically significant (p=0.016) better situation for girls in the oedematous group concerning the indicator W/A. The indicator for stunting also shows a better result for girls but being significant only under the 10% level. (Table 3–3)

Table 3 – 3: Nutritional status by sex in non-oedematous (NO) and oedematous (O) children

Nutritional status	**W/A mean z -scores (SD)**		**H/A mean z -scores (SD)**		**W/H mean z -scores (SD)**	
Sex	Groups		Groups		Groups	
	NO	O	NO	O	NO	O
Boys	-2.67 (1.35)	-3.54 (1.35)	-3.55 (2.14)	-5.16 (1.87)	-0.72 (1.91)	-1.26 (1.11)
N	47	15	47	15	47	15
Girls	-2.48 (1.35)	-2.67 (1.07)	-3.38 (2.07)	-3.41 (1.73)	-0.48 (2.28)	-1.06 (1.05)
N	29	13	29	13	29	13
Significance p=	n.s.	0.016	n.s.	0.075	n.s.	0.624

Table 3 – 4: Sex distribution (in %) in post-kwahiorkor (p-K) and post-marasmus (p-M) children

Nutritional status	p-K n=12	p-M n=26
Sex		
Boys	25.0	65.4
Girls	75.0	34.6

As was shown in Table 3–4, three quarters of the children who acquired nutritional oedema after discharge from hospital were girls. Marasmic children were much more often boys.

Concerning the **age specific classification** of the nutritional status in the oedematous and non-oedematous group, the prevalence of stunting in all age groups was extremely high, but an increase of stunting with age can be observed in both investigated groups with a peak at the age group of 7 to 10 years. The sample was too small to see if at an older age children will improve in their nutritional status. According to UNICEF (UNICEF 1996), the number of children showing underweight was reported to rise sharply between ages 1 to 2 years up to 54%, and thereafter to stabilise at 40%. In this sample between the ages of 4 to 6 years at least 70% of the children were underweight which reflects the high stunting prevalence in the sample.
The prevalence of stunting and underweight was substantially higher in the oedematous group. All children up to the age of 6 years, who had oedema after discharge from hospital, were underweight (WAZ < -2). At the same time, the children up to the age of 3 years were stunted. Also, 71% of the children in the age group between 4 and 6 years were stunted. The children who did not get nutritional oedema after discharge from hospital had on average a better nutritional status, even though stunting and underweight were common in this group as well.

Considering the prevalence of acute malnutrition (wasting) at the end of the study, the mean W/H z-scores for all age groups (Table 3-5 and Table 3-6) were in the normal range, including the oedematous group.

Table 3 – 5: Nutritional status in oedematous children by age group

	WAZ		HAZ		WHZ		
Age group (years)	Mean z-score ±SD	%	Mean z-core ±SD	%	Mean z-score ±SD	%	n=28
≤ 3	-3.22±0.45	100.0	-4.05±1.27	100.0	-1. 46±1.15	33.0	3
4-6	-2.98±1.49	100.0	-4.22±2.30	70.5	-0.98±1.09	29.4	17
7-10	-3.44±1.04	33.0	-4.73±1.52	87.5	-1. 45±1.03	25.0	8

Table 3 – 6: Nutritional status in non-oedematous children by age group

	WAZ		HAZ		WHZ		
Age group (years)	Mean z-score ± SD	%	Mean z-score ± SD	%	Mean z-score ± SD	%	n=75*
≤ 3	-1.95±1.43	46.1	-2.75±2.15	73.0	-0. 42±0.99	3.8	26
4-6	-2.86±1.35	72.7	-3.55±1.99	69.7	-1.36±1.00	18.2	33
7-10	-3.07±0.78	92.9	-4.66±1.83	92.8	0.05±2.99	14.3	14
11-14	-3.51±0.34	100	-3.79±1.25	100.0	3.63±9.00	50.0	2

*3 children could not be measured

3.4.2 Occurrence of nutritional oedema in the index children

Table 3-7 shows how many children in the different groups acquired oedema after discharge from hospital. As is evident from Table 3-7, children who were once admitted to hospital with kwashiorkor acquired more often oedema after discharge (43%) than children who were admitted with marasmus (11%) or the control children (3%) (p<0,001).

Table 3 – 7 : Sample of the study differentiated according to the occurence of oedema after discharge from hospital

Clinical classification	Non oedematous children	Oedematous children	n=
Control	29 97%	1 3%	30
Kwashiorkor	33 57%	25 43%	58
Maramus	16 89%	2 11%	18
Total n=	78 74%	28 26%	106

4 BASIC AND UNDERLING CAUSES OF MALNUTRITION, ESPECIALLY OF KWASHIORKOR

4.1 General structure of households

In this study the household was defined as a group of persons living and eating together who have a common head of household (World Bank 1992).
The studied households consisted mainly of the nuclear family, which includes the head of household (in most cases the father), the caregiver of the children (usually the mother) and their children (child/ren might also be step-child/ren or adopted). Extended families were not common among the studied population. Nevertheless, parents or siblings of the heads of household or the caregivers were often living in the neighbourhood of the patients’ homes. On average, 6.1 household members were living permanently together, without significant differences between the investigated groups. The control households and the households with a child treated for kwashiorkor in Yirga Alem Hospital had an average of 6.1 household members (median control households: 5.0, median kwashiorkor households: 6.0), followed by the households with a marasmic child treaded in the hospital with 5.9 household members (median: 6.0). According to the classification of oedematous and non-oedematous children after discharge from hospital, on average 5.9 household members were living in the households with an oedematous child (median: 6.0) and 6.5 household members were living in the households without an oedematous child (median: 6.0).

4.2 Educational status of primary caregivers and heads of house holds

Education of the caregiver is often associated with a greater commitment to care for the child. Educated women tend to provide better home health care and hygiene, and they are more likely to seek help when a child is ill (LE VINE *et al.* 1991, RICHMAN *et al.* 1992, JOSHI 1994).

4.2.1 Method

In this study an education index was built through the education of the caregiver and the head of household. The following scoring system was applied: A score of “0” was applied if the person under study (a) was not able to read or write, (b) able to read but had not attended any school, (c) had visited a traditional school.

In case the primary school was visited, a score of +1 was allocated. If the secondary school was finished +2 was added. The education index was generated by summing up the education of the caregiver and the head of household. Finally, scores from 0 to 4 resulted out of the analysis. This index will be included in the final logistic regression model (Chapter 6.2).

4.2.2 Results

In the study sample the illiteracy rate was very high, but there were differences between the investigated groups. Results show that more caregivers in the oedematous group never entered school than caregivers in the non-oedematous group (81 and 61%, respectively). In the healthy group there were at least 36% of women who obtained primary school education versus only 16% of caregivers of oedematous children. The 1990 Fertility and Family Survey (CENTRAL STATISTICAL AUTHORITY 1991) reported that 10.4% of 15- to 49-year-old females in rural areas were literate. Thus it seems that there was a gain made in reducing illiteracy, but data still remain very high in this sample. The education differences in this study were more important for the men (Table 4-1). Significantly ($p< 0.05$) more of those in the non-oedematous group had a better education than in the disease group. As it was checked in the home visits, the householders with at least basic education taught their wife how to care for the child in the right way. In the oedematous group there were even 60% of households, in which neither the head of household nor the caregiver obtained basic education, whereas in more than 75% of the non-oedematous group at least one of the parents had some education. The education index was highly significant correlated to the occurence of nutritional oedema ($p=0.000$, $r=-0.350$).

Table 4 – 1 : **Education index of the parents from non-oedematous and oedematous children**

Education Index:	Scores allocated	Results Non-oede-matous (%)	Results Oede-matous (%)
Education of caregiver:			
No official school	Yes: 0	Yes: 61	Yes: 81
Primary school	Yes: 1	Yes: 36	Yes: 16
Secondary school	Yes: 2	Yes: 3	Yes: 3
Education of men:			
No official school	Yes: 0	Yes: 21	Yes: 50
Primary school	Yes: 1	Yes: 52	Yes: 43
Secondary school	Yes: 2	Yes: 27	Yes: 7
Education index of parents together (summed together)			
	0	24	60
	1	30	19
	2	26	19
	3	18	3
	4	2	-

The differences of the education index concerning the ex-PEM and control groups were not significantly different (Table 4-2), even though the mean index was lowest for the kwashiorkor group.

Table 4 – 2 : **Education index of parents from ex-PEM and control children** (Mean, median, SD, minimum and maximum)

Clinical classification		Education Index
Control	Mean	1,5
	SD	1,1
	Median	1.0
	Minimum	0.0
	Maximum	4.0
Kwashiorkor	Mean	0.9
	SD	1.0
	Median	1.0
	Minimum	0.0
	Maximum	3.0
Marasmus	Mean	1.4
	SD	1.1
	Median	1.5
	Minimum	0.0
	Maximum	3.0

4.3 Economic situation of the households

In this chapter the economic situation of the households including data of income, expenditures and food expenditure will be described to find out how important economic determinants are in the aeetiology of PEM, especially kwashiorkor.

4.3.1 Background

The most important conclusion of the recent World Food Summit was that the supply of food is no longer a major determinant of malnutrition in the developing world. Rather, it is a lack of purchasing power, ignorance about nutrition, and subjective tastes or preferences that prevent some households and individuals from securing adequate diets. Some households spend more on food and other consumer items than would be needed for a minimum balanced diet (DOV CHERNICHOVSKY *et al.* 1997).

In the light of the development of malnutrition, and kwashiorkor in particular, it will firstly need to be proven whether level and sources of income differ between the investigated groups. Secondly, it would need to be established if food expenditure in quantity and quality (on which foods the budget was expended for), and in particular, whether the share in food expenditure to the total consumption expenditures (food budget share in %) differ between the investigated groups. Moreover, seasonal influences on income and expenditures will be assessed.

4.3.2 Method

Income and expenditures were registered during home visits all 4 months using standardised questionnaires. The head of household as well as the caregiver were asked to estimate cash income attained during the last 4 months period. To increase the reliability of the data, the head of household was asked how much of the income he gave to the caregiver. At the same time the caregiver was asked separately how much she got from her husband.
Answers were given in Birr, the Ethiopian currency. 1 US $ was equal to 7.2 Birr at the beginning/end of the study. Figures were estimated through summarising daily

income and expenditures throughout one week and summing the weekly income/expenditures to the monthly income/expenditures. To get information about the income it was asked how much they sold from their agricultural products etc. and how much they were earning through other income sources. This procedure was done for all months to be investigated. Finally, the four months were summed-up. Gifts (food) were not taken into consideration for the calculation of the income, because households rarely mentioned that gifts were given. The estimation of income/expenditures made a high demand on the interviewing skills of field personnel. By means of the close contact of the interviewing personnel to the families, registration of the data was no problem and the answers can be considered as good estimates of household's income and expenditures.

Analysis was carried out for groups classified at hospital admission as well as for groups classified according to occurrence of nutritional oedema in all children (also the siblings of the index child) from all households during the study period after discharge from hospital.
Statistical analysis was performed with SPSS. For tests of comparison between the three separate groups, Shaffer correction was used to get the overall significance.

4.3.3 Results

4.3.3.1 Monetary income

The following chapters will give an overview of absolute and per capita income in the households investigated.

4.3.3.1.1 Absolute income

Absolute income disaggregated by type of clinical classification as categorised at the time of admission

Income of the three investigated groups are demonstrated in Figure 4–1 according to the different seasons of the year. Each season comprises four months.

Throughout the year as well as in each season, the control group had the highest income compared to the ex- PEM-group. Highly significant differences between the groups (p=0.000) were observed if the year was taken as one unit. In addition, seasonal differences between the groups could be found in the pre- (p=0.002) and the post-coffee season (p=0.000).

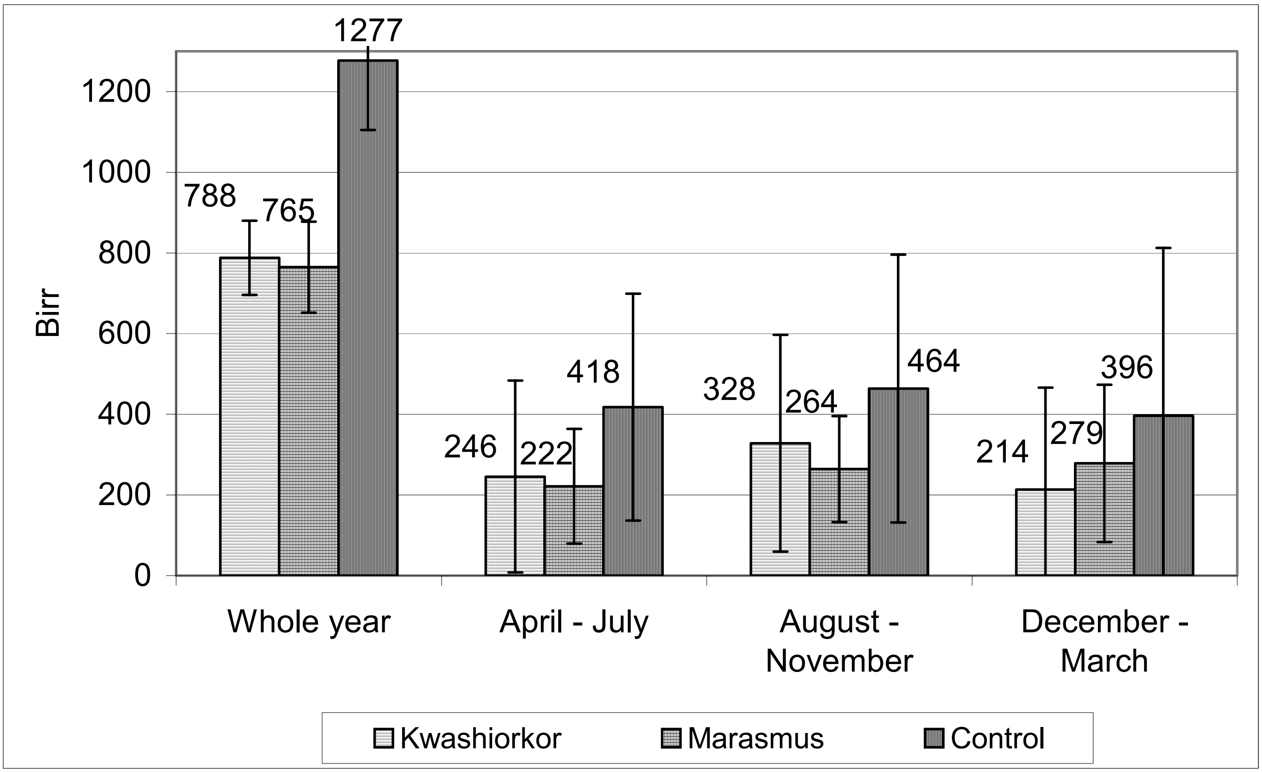

Figure 4 – 1 : Absolute income (Birr) by season, households with ex-PEM children and controls

According to median tests with Shaffer correction the income of the control group was, separately compared to this of the kwashiorkor group, significantly higher on the 0.01 level throughout the year (overall p<0.01) as well as in the pre- (overall p<0.01) and post-harvest season (overall p<0.01). Compared to the marasmus group, the income of the control group was significantly higher throughout the year (overall $p<0.05$), and to a strongly significant extent in the pre-harvest season (overall $p<0.01$). The kwashiorkor and marasmus groups did not show any significant differences of income throughout all seasons.

Seasonal income variations

The assessment for seasonal differences for each group indicates that the control group had no outstanding seasonal income variations, whereas the kwashiorkor group was exposed strongly to seasonal influences. The income of households with an ex-kwashiorkor child was in the coffee season higher to a highly significant extent than the income in the pre-coffee season (sign test, overall $p<0.01$) as well as in the post- coffee season (overall $p<0.001$). For the marasmus group the income was in the coffee season higher to a highly significant extent than in the pre-coffee season (t-test, overall $p<0.05$), but no significant difference could be shown between the coffee and the post-coffee season. These results indicate that households where kwashiorkor was registered, were highly dependent on the income earned during the coffee harvest whereas they live with a steady low income during the rest of the year.

4.3.3.1.2 Income per capita

For an assessment of the economic situation of the households investigated and the possible economic impact on the development of malnutrition, especially kwashiorkor, the average reported cash income of the three groups doesn't give enough information for proving the impact of this determinant. Moreover, since the size of the household may have an influence, the monetary income per capita for all groups was analysed.

Income per capita according to the classification as categorised at the time of hospital admission

Annex A 4–1 illustrates the per capita income data of the three investigated groups, classified at hospital admission. The income per capita throughout the year was significantly different ($p=0.012$, Kruskal-Wallis test) between the groups, with the control group having the highest per capita income. The difference between control group and kwashiorkor group separately was also significant (Kruskal-Wallis test, overall $p<0.05$) over the time period of one year.

Especially in the pre- and post coffee season (overall $p<0.05$) income differences between the investigated groups were observed. The pre-coffee season from April to July was the season where the highest differences between the per capita income of the control and both PEM-groups were registered (control and kwashiorkor group: overall $p<0.01$; control and marasmus group: overall $p<0.05$). Between the control and the kwashiorkor group income differences (overall $p<0.05$) could be shown as significant in the post coffee season only. During the coffee harvesting time, it was the marasmus group which was worse off compared especially with the control group (median-test: overall $p<0.05$).

To understand possible differences between the economic backgrounds of the kwashiorkor and the marasmus groups the per capita income in households with an oedematous child after discharge was compared to the per capita income in those households who brought a marasmic child to hospital and who did not have an oedematous child after discharge. The oedematous group had a significantly lower per capita income ($p=0.038$, t-test) than the former marasmus group with no occurrence of nutritional oedema throughout the year (Annex A 4–1). Differences were particularly significant before and after the coffee harvesting seasons between the two groups (April to July: $p=0.019$, median test and December to March: $p=0.038$, t-test). These results show the frightening economic situation of the households with a kwashiorkor child before and after the coffee season.

Seasonal per capita income variations

As demonstrated above, the kwashiorkor group did not only have the strongest seasonal variations with respect to the household’s average income, but also with respect to the per capita income. The per capita income in the coffee season was significantly higher (overall $p<0.01$) than in the pre-coffee season and higher to a highly significant extent than in the post-coffee season (overall $p<0.001$). For the other groups no important per capita income differences between the seasons were found. These results support the finding that those households belonging to the kwashiorkor group relied mostly on the income during the coffee season, whereas the other groups find ways to balance their income throughout the seasons (see Chapter 4.3.3.1.4 Sources of income).

Income per capita according to the occurrence of oedema

Not only the average cash income but also the per capita cash income turned out to be lower in the households with an oedematous child.

As shown in Annex A 4–1, the households where an oedematous child was registered after discharge from hospital had throughout the year investigated as well as in all separate seasons a significantly lower per capita income than the households where no oedematous child war registered. For the entire year and the season from December to March the significance level was $p<0.01$ (Median test), for the pre-coffee season and the coffee season it was $p<0.05$ (Kruskal-Wallis test).

Frequency distribution within groups of income

Since the standard deviation of income, expenditures and expenditures for food were quite high, terciles on the basis of entire income, total expenditures and expenditures for food from all observed households were calculated for the entire study period as well as for the three seasons during this period, separately. Finally, frequencies of children - according to clinical classification and according to oedema occurrence in the households after discharge - in each tercile were analysed for all aspects of income/expenditures. The results are shown in Annex A 4–2 and Annex A 4–3.

According to the clinical classification applied in the hospital, there were no significant differences between the groups according to income terciles, with exception of the season from April to July (p=0.014), Annex A 4–2 . But, it was obvious that households who had an oedematous child after discharge from hospital, were economically worse off throughout the year than households where no child acquires nutritional oedema. More households with an oedematous child were in the lower income group (Annex A 4–3). For the whole year period (p=0.029) as well as for the seasons between April and July (p=0.005) and between August and November (0.027) the differences in the distribution were significant. Similar results were reported by Goodall (GOODALL 1979). In a comparison of families where the father's income was thought to be low or non-existent with those where the father had a better job, significantly more children with kwashiorkor had fathers with a poor income. However in this study a family which was found to be wealthy may also pose a handicap to the child: the family can afford a house-girl, whose mismanagement of their son's diet resulted in the advent of kwashiorkor. Wray (WRAY 1969) also found that less malnutrition is found in the higher income groups. Annex A 4–3 also reveals the fact, that higher income does not prevent the occurrence of nutritional oedema.

Relation between entire income and occurrence of nutritional oedema

Out of the economic background of the households described above, it is not clear whether a shortage of income had an impact on the development of oedema in children or whether the fact that children fell ill caused additional financial burden to those households. According to discussions and observations both facts may strengthen each other.

To follow up the question how far the income had an influence on the occurrence of nutritional oedema a logistic regression was performed between the total average income throughout the year and the occurrence of oedema in all observed households.

According to the logistic regression there was no significant influence between income and the occurrence of oedema for the index children as well as for the occurrence of oedema in the entire family. Thus, beside the economical determinant, there must be other influences on the occurrence of oedema.

4.3.3.1.3 Gender aspect in income generating activities

Table 4-3 demonstrates the economic problem of the households with ex-PEM-children.

In no control household was the woman the sole earner of the household whereas in the PEM groups a substantial number of households were dependent on the sole income of the woman across all seasons. The reason for women as sole earners might be a female headed household or the male head of household being ill or not present. Since women in this region usually don't farm, they were depending on income from the sale of butter, preparing or selling *kocho* or *injera* (see Annex Photo-documentation), selling of baskets or potteries etc. With these sources of income, the women only obtain a small income. Thus, the income of these households was extremely low. On average, the women earned Birr 132.6 (SD 85.8) in the pre-coffee season, compared to the average income of male earners with Birr 314.4 (SD 261.9). In the coffee season the income of the female earners was slightly higher: Birr 150.5 (SD 69.1), with also the men's income being higher: Birr 372.7 (SD 254.0).

In the post-coffee season the income of the women was falling to nearly the level of the pre-coffee season: Birr 139.2 (SD 114.3). Also the men's income decreased (Birr 324.6), but was much higher than the income of women. The differences between the female and male earners were significant in all seasons ($p<0.05$).

Table 4 – 3 : Frequency of kwashiorkor/marasmus in households where women were the sole earner of the household

Season	Control (in %)	Kwashiorkor (in %)	Marasmus (in %)	Significance level p=
Pre-coffee season	0	22.6	11.1	0.022
Coffee season	0	19.6	18.8	0.047
Post-coffee season	0	29.6	40.0	0.003

4.3.3.1.4 Sources of income

Sources of income were grouped in categories as follows:

- income from own agricultural production and livestock;
- regular monthly income;
- labour work e.g. stone work, farming, construction work including merchant activities (buying and selling products, selling wood, rent houses etc.);
- borrowed money/gifts.

Sources of income according to clinical classification as categorised at hospital admission

Table 4-4 describes the relative frequency of households with ex-PEM children and controls with income from the different sources. In addition, those households depending entirely on certain sources of income (100% of income) are listed.

As can be seen in Table 4-4, the ex-PEM-groups –kwashiorkor and marasmus- showed strong seasonal variations concerning income from the sale of agricultural products. It is obvious that households from the marasmus group, compared to the other two groups, sold much less agricultural products/livestock. Only every third household from this group received income from the sale of their own products. Only during the coffee season every second household in this group achieved income from this source. Table 4-4 also lists the households depending entirely on one source of income only. Whereas at least 40% of households of the controls were relying solely on the sale of their own products across all seasons, the households from the illness groups were stronger involved in labour/merchant activities across all seasons. In the pre-coffee season (p=0.026) and in the coffee season (p=0.044) the differences were significant. In the pre-harvest season the households of the kwashiorkor and marasmus group depended on income from labour work/merchant activities to 64% and 56% respectively, the control group were to only 40% obtaining income from those activities. Moreover, for an important number of households of the marasmus group labour work was the sole source of income (50% in the pre-harvest season and nearly 40 % during the rest of the year). 76% of the farmers of the control group, 81% of the kwashiorkor group and 69% of the marasmus group had coffee in the garden. Out of those, most of the farmers used coffee as an income source: 63% of the kwashiorkor group were selling some coffee, compared to 73% of the marasmus and 79% of the control group. As mentioned in Annex A 4–5, the farmers of the control group had the highest coffee harvest on average, whereas the farmers from the marasmus group had the lowest harvest. On average, the income from the sale of coffee made up about 42% of the entire income in the coffee season for the farmers of the control group. A comparable figure was shown for the kwashiorkor group (about 40%), whereas the marasmus group received the lowest part of their entire income from coffee in this season.

Regular income did not play a significant role as a source of income in this sample, but more households from the control group had a regular income during all seasons. In the post-coffee season the differences between the groups were significant (p=0.045) in terms of regular income. Also in the other seasons at least twice as many households of the control group obtained regular income compared to the illness groups.

Table 4-4 also demonstrates that some of the households, mostly in the illness groups, were depending on money given as gift or borrowed money. The marasmus group was especially dependent on financial help in the pre-harvest season. 17% out of this group obtained money as gift or loan and 11% depended totally on financial help. In the kwashiorkor group about 10% of the households depended on financial help in the pre- and post-coffee season.

Table 4 – 4: Sources of cash income for households with ex-PEM children and controls
Relative frequency of households with income from the specific sources of income and households depending entirely (100%) on specific sources of income

	Control	**Kwashiorkor**	**Marasmus**	**Significance level**
	n=30	n=58	n=18	p=
	%	%	%	
Season April- July				
Agricultural products	60	50.0	33.3	n.s.
100% of income	40	22.4	22.2	
Regular income	10	5.2	5.6	n.s.
100% of income	6.7	1.7	5.6	
Labour /merchant	40	63.8	55.6	0.026
100% of income	24.1	36.2	50.0	
Borrowed/gift	0	8.6	16.7	0.095
100% of income	0	5.2	11.1	
Season: Aug. – Nov.				
Agricultural products	56.7	63.8	50	n.s.
100% of income	40.0	29.3	27.8	
Regular income	13.3	3.4	5.6	n.s.
100% of income	10.0	3.4	5.6	
Labour /merchant	36.7	62.1	66.7	0.044
100% of income	26.7	27.6	38.9	
Borrowed/gift	3.3	5.2	5.6	n.s.
100% of income	0	1.7	0	
Season: Dec. - March				
Agricultural products	66.7	60.3	33.3	n.s.
100% of income	46.7	36.2	22.2	
Regular income	16.7	1.7	5.6	0.045
100% of income	3.3	1.7	5.6	
Labour /merchant	36.7	48.3	55.6	n.s.
100% of income	13.3	27.6	38.9	
Borrowed/gift	0	10.3	5.6	n.s.
100% of income	0	1.7	0	

n.s.: not significant

Figure 4-2 shows the average percentage of income of different sources of income. The most obvious differences between the groups can be seen in the pre-harvest season from April to July. Whereas the control group received the highest part of their income on average from their agricultural production, the illness groups obtained their income to a much higher extent from labour work and merchant activities. Independent of seasonal influences, the control group received about 40% of their income from the sale of their own produced goods throughout the year. Moreover, they were nearly independent of gifts or credits. The illness groups showed strong seasonal influences concerning their income of their own production. In the pre-harvest season only about a quarter of their income came from their own production, whereas they received about 50% from other sources of income, especially from labour work or merchant activities.

Figure 4-2 indicates also some differences between the kwashiorkor and marasmus group. The marasmus group was the group with the least activities on their own land, especially in the post-harvest season. Throughout all seasons they achieved their highest part of income from labour work/merchant activities, even more so than the kwashiorkor group. The kwashiorkor group -compared to the marasmus group- had more income from their own production.

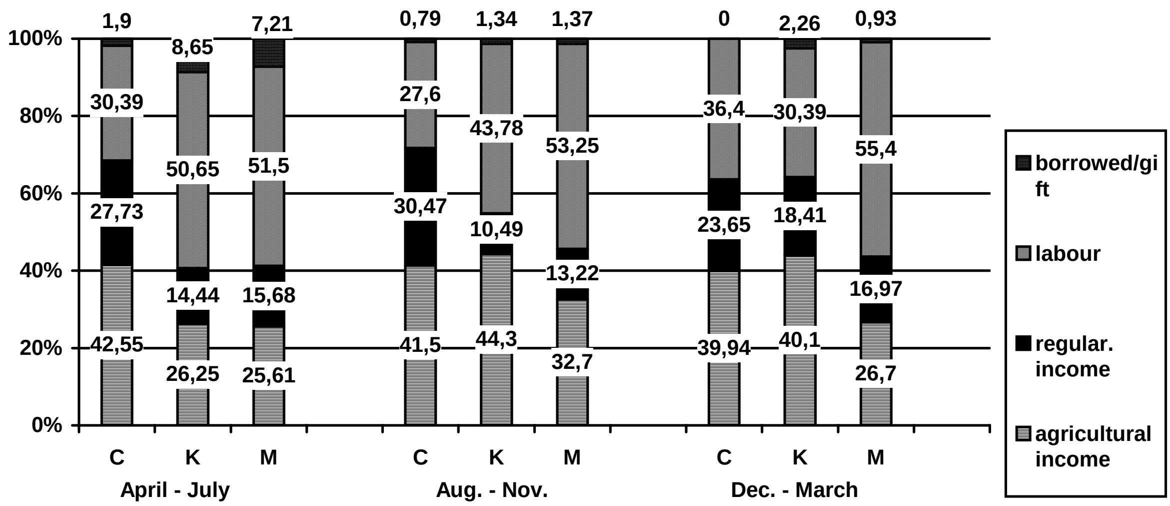

Figure 4 – 2: Sources of income (average % of entire income) during the seasons, households with ex-PEM children and controls (Control: C; Kwashiorkor: K; Marasmus: M)

A discussion about signs of poverty in a Sidama family confirmed the results from the quantitative assessment of sources of income. Richer families are able to pay off labour workers to work on their farms, whereas poor families work in the fields for other farmers. A better harvest on the farms of richer families is the consequence. In our survey the results show that the PEM-groups did not only have a smaller income but also were more dependent on labour jobs or other low paid sources of income. There did not seem to be an overproduction in this group to get a comparable high income as in the control group.

Sources of income according to the occurrence of oedema

The following figures were computed with the same methods as described above for the clinical classification. The frequencies of households in different groups of sources of income as well as the frequencies of households depending on one source of income only are listed in Table 4-5.

Table 4-5 shows that in the pre-harvest season only 41% of households of the oedematous group were getting income from the sale of agricultural products and animal husbandry compared to 55% of the non-oedematous households. Moreover, only about 11% of the oedematous group were relying solely on their own production compared to 36% in the healthy group. The frequency of households receiving the entire income from their own production was even lower than in the former marasmus group (22%, Table 4-4)

In the coffee- and post-coffee season the number of households from the oedematous group receiving their income exclusively from the sale of their own products increased steadily, whereas those obtaining their entire income only out of labour work/merchant activities decreased at the same time.

The difference of the average share of income out of the sale of agricultural products/livestock between the post-harvest and the pre-harvest season was significant in the oedematous group (p=0.049). The share of income as well as the average amount of cash income from labour work in the pre-coffee and the coffee season was higher in the oedematous group than in the healthy group. The oedematous group obtained especially in the pre-harvest season a significantly larger amount of their income (70%) from labour work/ merchant activities. This is in contrast to the non-oedematous households where only 49% obtained income from labour work/ merchant activities (p=0.026).

Moreover, if the total amount of money, obtained from the sale of agricultural products and animals, is compared, the non-oedematous group earned much more on average even though the share of income was smaller. In the pre-harvest season they earned on average 107 Birr compared to only 39 Birr in the oedematous group. In the coffee season this was 140 Birr and 118 Birr, and in the post-coffee season 100 Birr and 96 Birr, respectively. The productivity of the land in the oedematous households seems to be much smaller than in the healthy group (see chapter 4.4.2.1).

Obviously, the non-oedematous group had a higher share in income from regular payments throughout all seasons than the oedematous group (about a quarter of the average share of income compared to nearly no regular income in the oedematous group). This was significant in the post-harvest season (p=0.045).
During the pre-coffee season (the season with the highest occurrence of nutritional oedema) a large share of the oedematous group's income was even borrowed or received as a gift (16.2%, Table 4-5): The difference between the groups was significant (p=0.014).

Table 4 – 5 : Frequency distribution of households for different sources of income (any income or 100% income), non-oedematous and oedematous group

Sources of income	Frequencies of hhs having any income out of the following sources				Frequencies of hhs having 100% income out of the following sources	
Season: April-July	Non-oedematous		Oedematous		Non-oedematous	Oedematous
	n	%	n	%	%	%
Agricultural products	33	55.1	15	40.5	36.2	10.8
Regular income	6	8.7	1	2.7	5.8	0
Labour work/ merchant activities	33	48.5	25	70.3	29.4	45.9
Borrowed/gift	2	2.9	6	16.2	1.5	10.8
Season: Aug. – Nov.						
Agricultural products	41	59.4	22	59.5	33.3	29.7
Regular income	6	8.7	1	2.7	7.2	2.7
Labour work/ merchant activities	36	52.2	23	62.2	29.0	29.7
Borrowed/gift	3	4.3	2	5.4	0	2.7
Season: Dec. - March						
Agricultural products	38	55.1	23	62.2	34.8	40.5
Regular income	7	10.1	0	0	4.3	0
Labour work/ merchant activities	32	46.4	17	45.9	23.2	29.7
Borrowed/gift	2	2.9	5	13.5	0	2.7

4.3.3.2 Expenditures

In the light of the development of malnutrition and kwashiorkor in particular not only the monetary income is of interest, but also the assessment of how the investigated households use their income. Here, especially it is interesting how much of their income they use for food and how they behave in the different seasons throughout the year. For this reason, total consumption expenditures, food expenditure, the budget share for food (food expenditure of the total expenditures), and expenditures per capita, in total and for food were analysed (Figure 4–3 and Annex A 4–1). In addition, groups for food expenditure (terciles) were constructed and finally the frequency distribution of households within groups of expenditure was performed (Annex A 4–2 and Annex A 4–3). An analysis was carried out for the whole year and separated in seasons for both classifications, on the one hand the classification as categorised at admission, on the other hand, the classification according to prospective occurrence of nutritional oedema in children after discharge.

4.3.3.2.1 Total consumption expenditures

In the observed households almost nobody saved money. The median of the income spent is 100%. Differences of mean consumption expenditures in all households throughout the year were significant ($p=0.013$), with the control group spending the highest amount of money. The expenditures in the control group were according to the correction of Shaffer significantly higher than in the kwashiorkor group during the seasons from April to July (overall $p< 0.05$) and from December and March (overall $p<0.01$). The expenditure differences between the control and the marasmus group only proved to be significant during the season from April to July ($p<0.05$; $p=0.038$). The two illness groups were not showing significant expenditure differences.

4.3.3.2.2 Food expenditure

In the following chapters (4.3.3.2.3 to 4.3.3.2.6) detailed information on quantitative food expenditure are given. In the background of the analysis of determinants for the development of kwashiorkor beside the amount of money spent on food, it is interesting to know for what kind of food the households spent money. Chapter 4.3.3.3 will give an overview about the qualitative aspects of food expenditure.

4.3.3.2.3 Absolute food expenditure

Figure 4–3 demonstrates the mean food expenditure in the investigated groups, according to the classification at admission. The differences were significant throughout the year (p=0.0006) and within the seasons (Kruskal-Wallis test: April to July: p=0.001, August to November: p=0.029; December to March: p=0.002). The largest differences can be found between the control and the kwashiorkor group. Throughout all seasons the mean for total food expenditure was higher in the control group (April to July: p=0.0003 - Kruskal-Wallis, August to November: p=0.039 - Dunnet t-test- and December to March: p=0.0008, Kruskal-Wallis).

Seasonal variations of food expenditure

Only the kwashiorkor group had significant seasonal differences in food expenditure. During the coffee season they spent significantly more cash money than in the pre-coffee season (sign test, overall p<0.05) as well as in the post-coffee season (overall p=0.05). This result reflects the income situation of this group. Although the marasmus group had significantly less income in the pre-coffee season, the food expenditure were not significantly different between the seasons.

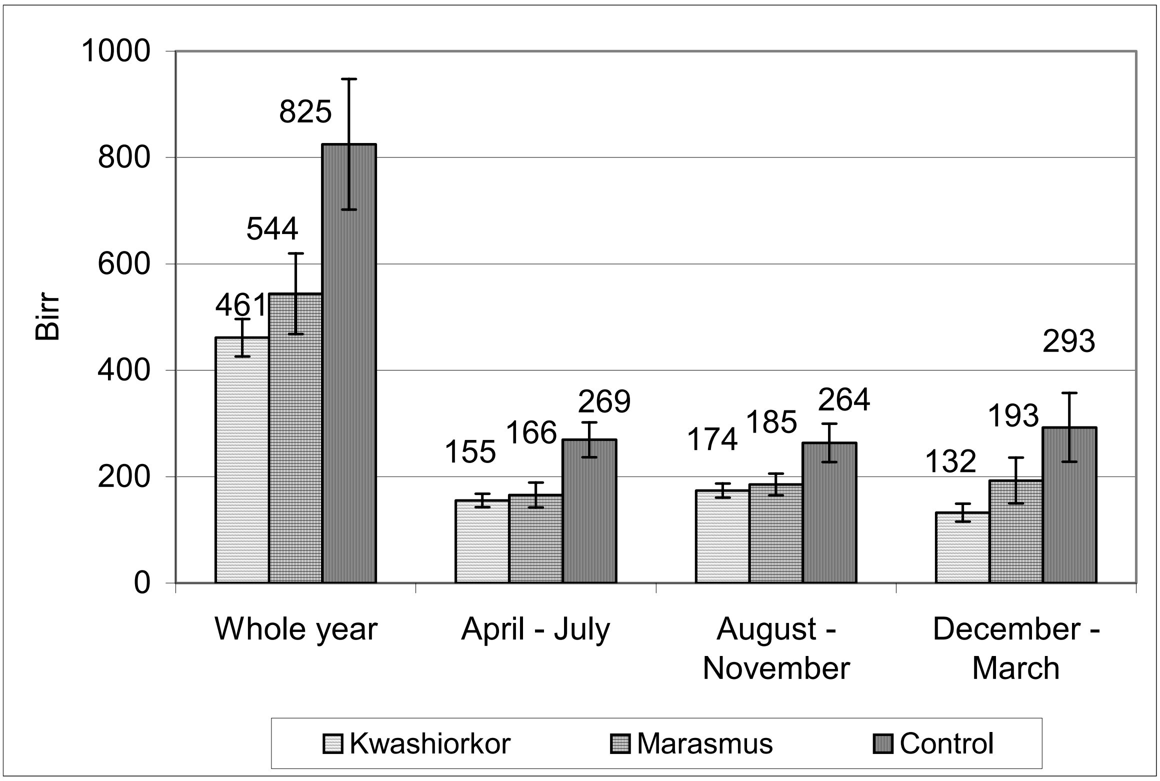

Figure 4 – 3 : Mean food expenditure (Birr) during the seasons for households with ex-PEM and control children

4.3.3.2.4 Food expenditure per capita

It is obvious that the quantity and quality of food available to the individual was limited by the amount of money actually spent per person in the household. This correlates well with the fact that the frequency of malnutrition rises as per capita food expenditure decreases (WRAY 1969).The food expenditure per capita will give more information about the food available to each household member. This term is used either as a continuous variable or as an expenditure group (terciles). Annex A 4–1 illustrates the per capita food expenditure in Birr during one year and separated into the different seasons.

Clinical classification according to hospital admission

From the data analysed it is clear that the control group spent for each household member more cash money for food throughout the year (Annex A 4–1). The differences between the groups were significant ($p<0.05$). But it also clarifies the food expenditure profile of the kwashiorkor and marasmus groups. Households from the marasmus group spent on average approximately 14 Birr throughout the year (which was equivalent to about 2 $) more for each household member than the kwashiorkor group, in the Ethiopian context quite a significant amount of money. Especially in the post-coffee season the marasmus group spent more money for food for each household member than the kwashiorkor group, since they also had a higher per capita income in this season (Annex A 4–1). The differences for the per capita food expenditures between the groups in the pre- and post-harvest season were highly significant. In order to distinguish between the economic background of households with a kwashiorkor and a marasmic child, the per capita food expenditure of all households with an oedematous child after discharge from hospital was compared to the per capita food expenditure of the families who brought their child to hospital with marasmus and who did not have an oedematous child after discharge from hospital. As mentioned above, the income per capita as well as the mean food expenditure of the former kwashiorkor group were lower than those of the former marasmus group. Moreover, the group with oedematous children spent significantly less per capita on food expenditure throughout the year ($p=0.026$-median test) and across all seasons: April to July ($p=0.019$, median test), August to November ($p=0.0024$-Man-Whitney test) and December to March ($p=0.028$, t-test) compared to those families who were bringing up their child with marasmus and who did not have an oedematous child after discharge. What is truly remarkable is the fact that such slight increases (less than 8 U.S. cents per person) per day seem to make such a difference.

Seasonal variations in per capita food expenditure

The data on per capita food expenditure highlight the extreme seasonal variations in food expenditure of the kwashiorkor group. During the coffee season this group spent more on food per capita compared to other seasons (the differences were significant with $p=0.021$ in the pre-coffee season and $p=0.015$ in the post-coffee season), but during the rest of the year the per capita expenditures were on a very low level.

Oedematous versus non-oedematous households

Expressed in currency unit of Ethiopia (Birr) Annex A 4–1 gives information about the extreme differences between the non-oedematous and the oedematous group. Throughout the year the households who did not present an oedematous child spent nearly twice as much money for each household member on food as households with an oedematous child after discharge from hospital (median test: p=0.003). The same effect can be seen if calculations were performed for different seasons. In the pre-coffee season (p=0.009) as well in the coffee season (p=0.028) the differences concerning the per capita food expenditure proved to be significant.
Moreover, the per capita food expenditure of the households with an oedematous child (Annex A 4-1) were lower throughout the entire year and in all seasons separately than the lowest average per capita food expenditure of the households of the former kwashiorkor or marasmic children.

4.3.3.2.5 The budget share for food

The share of food expenditure on total expenditures is an important indicator of poverty. If more than 75% of expenses are spent on food it can be supposed that it is a poor household (STREETEN 1994). In developing countries normally a 60 to 80% (LIPTON 1988, BELLIN 1991) share of expenditure is on food. In this sample, 50% of all households spent 66% or more (median: 66) of their expenditures on food.

The control and the marasmus group had a comparable budget share for food. In all groups the highest budget share for food was found during the season between April and July (pre-harvest season), the lowest in the coffee season depending on the harvest time of different crops. The budget share on food for families with a former kwashiorkor child was significantly below that of the other groups throughout all seasons, even though the income was comparable to those families with a child formerly classified as marasmus. This fact becomes clearer when the households were analysed according to the occurrence of oedema after discharge from hospital. Throughout all seasons the budget share for food was lower in the oedematous group than in the non-oedematous group (Annex A 4–1), but in both groups seasonal variations of the budget share for food were proved to be significant (p<0.05), with the lowest budget share for food in the coffee season. Observations and discussions with people living in the neighbourhood of families with a former kwashiorkor child pointed towards social difficulties in these families. For example, many of the household-heads were addicted to alcohol. Especially in the coffee time (food budget share (%): 53.6% in the kwashiorkor, 66.6% in the control, 67.0% in the marasmus group, respectively), they used to go to drinking places with their friends etc. and take food in local restaurants. Another reason for a lower budget share for food might be the higher expenses for medical treatments (see Chapter 5.1). The result indicates that the purchase of items other than food or the payment for services played a more significant role for those families than in other households.

4.3.3.2.6 Frequency distribution of PEM occurrence within categories of food expenditure

Since the standard deviations of food expenditure were quite high, the economic background of households with malnourished children, especially kwashiorkor, will be clearer when food expenditure throughout the year and during the seasons were divided into categories (terciles) of low, medium and high expenditures. Finally the frequencies of households in these categories were analysed. Annex A 4–2 demonstrates the expenditure terciles in the groups according to the clinical classification as categorised at hospital admission.

Whereas there were no significant differences between the groups in frequency distribution of households with a former PEM child for total expenditures throughout the year and during the seasons, there were significant differences between the groups for the food expenditure throughout the year (p=0.064, weakly significant) and throughout all seasons (the pre- and post coffee seasons with p= 0.038 and p= 0.020, respectively) (Annex A 4–2) with the exception of the coffee season, where there was only a weak significance (p=0.064). Annex A 4–2 demonstrates that especially the households of the kwashiorkor group were present in the lowest group of food expenditure, whereas in the control group most of the households belonged to the highest food expenditure category. The marasmus group had more than half of their households in the middle or high expenditure group throughout all seasons.

Oedematous versus non-oedematous households

Concerning the total consumption expenditures throughout the year as well as throughout all seasons more households of the oedematous group belonged to the lower group of expenditures, but it was only significant during the season from April to July, the pre-coffee season (p=0.032). This result attaches more importance if analysed together with the expenditures on food. Throughout the year (p=0.003) and throughout all seasons (p=0.038 for the pre-coffee season; p=0.009 for the coffee season and p=0.014 for the post coffee season respectively) significantly more households with an oedematous child were present in the lower group of food expenditure. When only relapse cases of kwashiorkor were analysed, highly significantly more families in the relapse group were in the lowest group of expenditures for food (p=0.036).

Summary

The results from the entire income and expenditures indicate that the kwashiorkor group was the group with the highest seasonal variations. In the pre- and post- coffee seasons they had a significantly lower income than in the coffee season so that the expenditures were significant lower during that time also. Throughout all seasons the budget share for food was lower than in the other groups. The tremendous bad economic background of households with kwashiorkor children gets clearer when households, who after discharge from hospital had an oedematous child, were compared to households where no oedematous child was registered. Over the entire study period the pre capita income as well as the per capita food expenditure of households with an oedematous child were below the lowest figures of the groups classified at admission (Annex A 4-1).

4.3.3.3 Qualitative description of food expenditure

The above mentioned results indicate that especially households with a former kwashiorkor child, and more clearly those households with an oedematous child after discharge from hospital, used a lower part of their income for food. On the assumption that those families were ignorant of nutrition, an assessment of the quality of the food purchased will be attempted in this Chapter. For this purpose the percentages of special food items in relation to the total food expenditure were calculated. All food items, which were bought at the market during the three different seasons of the study year, were registered in the Ethiopian unit of currency (Birr). It has to be taken into account that all the registered amounts of Birr have to be seen as estimates. The assessment was done according to the prospective classification during survey time after discharge from hospital (households with an oedematous versus non-oedematous child).

For the assessment of the quality of food purchases the following food items were formed into food groups:

- cereals: teff, wheat, barley;
- pulses: red kidney, beans, chick peas and peas;
- roots: potatoes, sweet potatoes, taro, godere;
- fruits;
- fat: oil, butter;
- animal-foods: buttermilk, egg, meet;
- others: spices (salt, chilli, sugar), other vegetables beside *gomen*, spaghetti, bread, biscuits, beverages (like fanta, coke) food bought at restaurants etc.

Ensete is shown separately as it is the main starch food in the Sidama zone. Maize, which belongs to the cereals is also shown separately, since it is the main cereal planted and consumed as main food besides *ensete* in this region. Also the Ethiopian cabbage *gomen,* the main vegetable planted in this region is separately analysed. Field observations and the exact measurement of food (Chapter 5.2.2.2) indicate that these foods comprised the principle diet, especially in the kwashiorkor group. In most households *kocho*, which is made out of *ensete*, is prepared with *gomen* and sometimes red kidney, a type of beans. *Maize kita* (see Figure 3-6*)*, a bread prepared out of maize powder is also belonging to the main dishes in Sidama.

Foods registered separately:

- *ensete*;
- maize;
- cabbage (*gomen*).

Annex A 4-4 explains the mean amount of Ethiopian currency (Birr) spent for the different foods. Figures 4-4 to 4-9 demonstrate the corresponding average percentage figures of those foods to the total food expenditure in the different seasons.

The data highlight the fact that households in which an oedematous child was registered during the study period decided to buy foods leading, in the long term, to an extremely unbalanced diet for the family and especially for the children. The Figures below illustrate -separated by season- that especially in the oedematous group a higher share of food expenditure was spent on ***ensete*** than in the non-oedematous group. This result can be attributed to a lower *ensete* harvest in the oedematous group which will be described in chapter 4.4.2.1. The amount purchased was especially high in the pre-coffee season; when other foods were scarce and cheap *kocho* was available at the market. It has to be borne in mind that *ensete* is the main agricultural product planted in this region. The median of money spent on this food at the market in different seasons was zero in all groups and throughout all seasons.

The highest share in food expenditure was spent on **maize** in both groups, but to a higher extent in the oedematous group. Again, it was in the pre-coffee season where the oedematous group spent the highest part of their money on this food. Whereas the non-oedematous group spent 29% of their food expenditure on maize in this season, it was 36% in the oedematous group. But it has to be considered that the non-oedematous group had a higher income. Thus, even though the share in expenditure was less for maize, the amount of maize bought at the market was higher in the healthy group and this especially in the pre- and post (p=0.09) harvest seasons. Whereas the non-oedematous group spent 46 birr on maize during the post-harvest season, the oedematous group spent only 30 birr.
One kilo of maize could be bought during the study period for about 1.5 Birr. So, per month, the non-oedematous households on the average purchased about 8 kg maize besides their own maize harvest whereas the oedematous households had only about 5 kg for their additional supply. Also the median was higher for the non-oedematous group throughout all seasons.

In the typical diet of Sidama people *ensete* as well as maize is mostly eaten together with ***gomen*****,** the Ethiopian cabbage. As observations show, it was especially in the oedematous group where these special dishes were prepared at any time without adding different foods to the diet. The *gomen* constituted a higher proportion of expenditures in the oedematous group than in the non-oedematous group during the coffee and post-coffee season (p=0.02 and p= 0.03 respectively). Less *gomen* was bought in both groups in the pre-coffee time, since it was the time of harvest in people's own gardens. In both groups the highest amount of *gomen* was purchased in the coffee season (on average 20 Birr in the control, and 22 Birr in the non-oedematous group respectively), but with exception of the pre-coffee season the oedematous group spent more money on this vegetable.

A sign of the extremely unbalanced diet in non-oedematous households was the significant difference in the purchase of other food items besides the main foods mentioned above. **Roots**, like potatoes, sweet potatoes, *taro* and *godere*, made up a small amount of expenditures in the healthy group, with a higher extent of food expenditure incurred before and after the coffee season. In the oedematous group, roots were not purchased at all. In the post-coffee season the amount of money spent on these foods was significantly higher (p=0.039) in the non-oedematous compared to the oedematous group (2 Birr compared to O Birr respectively).

Cereals, with the highest share being teff, the Ethiopian millet used for preparing *injera*, complete the dishes in this region. Cereals, especially teff, were bought to a significantly higher extent in the non-oedematous group throughout all seasons (p<0.01 for the pre-coffee and coffee season, p=0.046 in the post-harvest season). Whereas in the non-oedematous group a range from 8 to 10 % of food expenditure, according to harvest times, was used for cereals, in the oedematous group, across all seasons a negligible share of 1% was spent on cereals. But not only was the share in expenditures for cereals higher in the non-oedematous group, also the average amount of money spent on cereals was on a much higher level. The healthy group spent on average 51 Birr in the post-harvest season whereas the oedematous group spent only 3 Birr on these foods. The price for one kilogram of teff at the time of this study was about 2.50 to 3.00 Birr. Therefore, the households with an oedematous child purchased on average only about 1 kg of teff for 4 months for the entire family. The amount of cereals bought at the market was significantly higher in the healthy group across all seasons than in the oedematous group (p=0.003, season April to July, p= 0.006, season August to November, p= 0.047 season December to March). It has to be borne in mind that most of the farmers in this region did not plant their own teff. Thus, teff bought at the market was the only source for the families diets.

The impression that the oedematous group had a very unbalanced diet was strengthened when the figures for **pulses** were analysed. In the non-oedematous group not only a higher share of food expenditure was used for pulses compared to the oedematous group (in the pre- and coffee season p<0.05), but also the absolute amount of money spent and so the amount of pulses consumed was higher in the healthy group. The median of money spent on pulses was much higher in the control group than in the illness group throughout all seasons. In the pre-harvest-season (April to July) the purchase of pulses was lowest in all investigated groups. This season was considered the hardest for all households. Nevertheless, the non-oedematous group bought nearly three times as many pulses (on average: 28 Birr, median 18 Birr) in this season as the oedematous group (on average: 11 Birr, median 4 Birr) (p=0.003).

Animal products did not play a significant role in the diet of both groups. Most respondents reported to eat meat mainly at yearly traditional celebrations (September, January and April). On average less than 5% of the food expenditure were spent on buttermilk, eggs and meat, but since the non-oedematous group also had higher average food expenditure the amount of Birr spent on those foods was nearly twice as much throughout all seasons. For example in the coffee season they spent about 10 Birr on animal products compared to only 5.6 Birr spent in the oedematous group (p=0.087), but throughout all seasons the median was 0 in both groups i.e. less than half of the families bought these products. The price for one kilogram of meat was about 15-20 Birr, for one litre buttermilk about 2 Birr and for 3 eggs about 1 Birr. The prices of animal products compared to products from plants make it clear why these foods played an unimportant role in the people's diet unless they were using their own livestock as their main source of these products. The highest consumption of animal products took place in the families from the control group, classified at admission. The median was 19 Birr in the coffee season and 8 Birr in the post-coffee season. Only in the pre-coffee season was the median also 0 in this group.

Foods rich in fat: foods rich in fat (oil and butter) also constituted less than 10% of food expenditure, but the non-oedematous group spent a significantly higher extent of their food expenditure on these products throughout all seasons (p<0.05 for the coffee and post-coffee season). The lowest part of food expenditure was spent on butter and oil in the time between April and July, the pre-harvest season. The oedematous group spent significantly less money on these products than the non-oedematous group (p=0.028). Concerning the absolute amount of money spent on foods rich in fat, the non-oedematous households spent significantly more on these foods throughout all seasons (p=0.0009, season April to July, p= 0.0001, season August to November, p= 0.009 season December to March). For example in the post-coffee season more than twice as much food rich in fat was purchased by the non-oedematous group (mean:21 Birr and 9 Birr respectively).

Spices, like chilli, red pepper, salt and sugar, made up quite an important share of the food expenditure in both groups and made up the highest part in the food group **"others"**. The amount of money spent on spices (Annex A 4–4) was higher (p=0.052 in the post-coffee season) throughout all seasons in the healthy group. Whereas the median in the pre-coffee season was 12.0 Birr in the non-oedematous group, in the oedematous group it was only 7.2 Birr. In the coffee and post coffee season it was 17 and 16 Birr respectively in the non-oedematous group and only 12 in both seasons in the oedematous group.
On the other hand, the percentage of expenditure for spices of total food expenditure (which made the highest part of foods classified as "others") was even higher throughout all seasons for the oedematous group compared to the non-oedematous group. In the post-coffee season they spent about 17% on spices compared to only about 12% in the non-oedematous group. It was quite astonishing that in both groups the proportion of money spent on spices was higher than the part spent on products rich in fat. This was especially the case for the oedematous group. Whereas they spent 17% of the food expenditure on spices in the post-coffee season they only spent about 7% for oil and/or butter.

Fruits, other vegetables and spices were purchased in very small amounts, but it was the control group in all cases which spent more money on these foods than the oedematous group. The main source of fruits was from own production. In addition, fruits were sometimes received from relatives, neighbours or friends. Coffee was not bought at the market in either group.

To **summarise**; the non-oedematous group purchased other cereals in addition to the main starch food *ensete* and maize, especially teff, and pulses. Foods rich in fat also made up a significantly higher portion of the diet. All other foods were bought in greater quantities in the non-oedematous group. Especially for children of the oedematous group, who were too young or too weak to get additional food from outside their own house, their diet was extremely unbalanced, based only on *ensete*, maize and *gomen* and lacking foods rich in protein and fat. The purchasing behaviour of oedematous households suggests a lack of foods providing sulphur-containing amino acids, such as animal products or cereals such as teff and wheat. Moreover, these foods are rich in micronutrients such as zinc and selenium. More details about the oedematous children's meeting of nutritional requirements are analysed in Chapter 5.2.2.2 Adequacy of the diet.

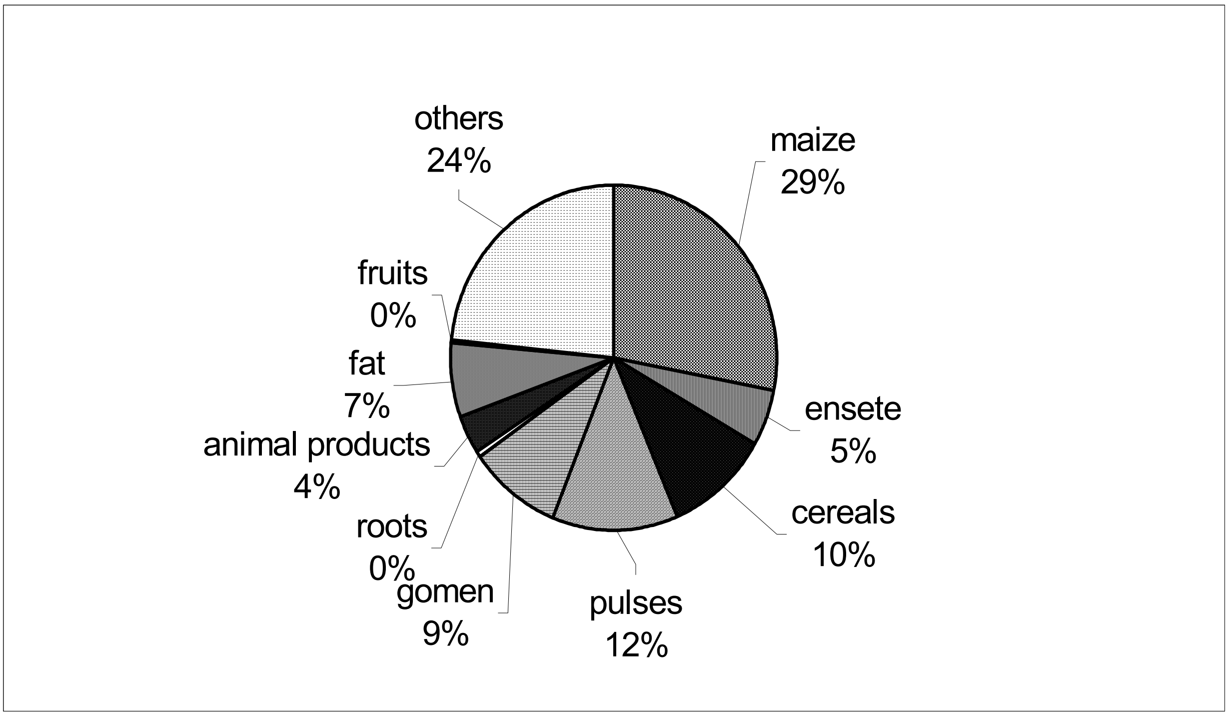

Figure 4 – 4: **Share of food expenditure for different foods in the pre-harvest season – non-oedematous group**

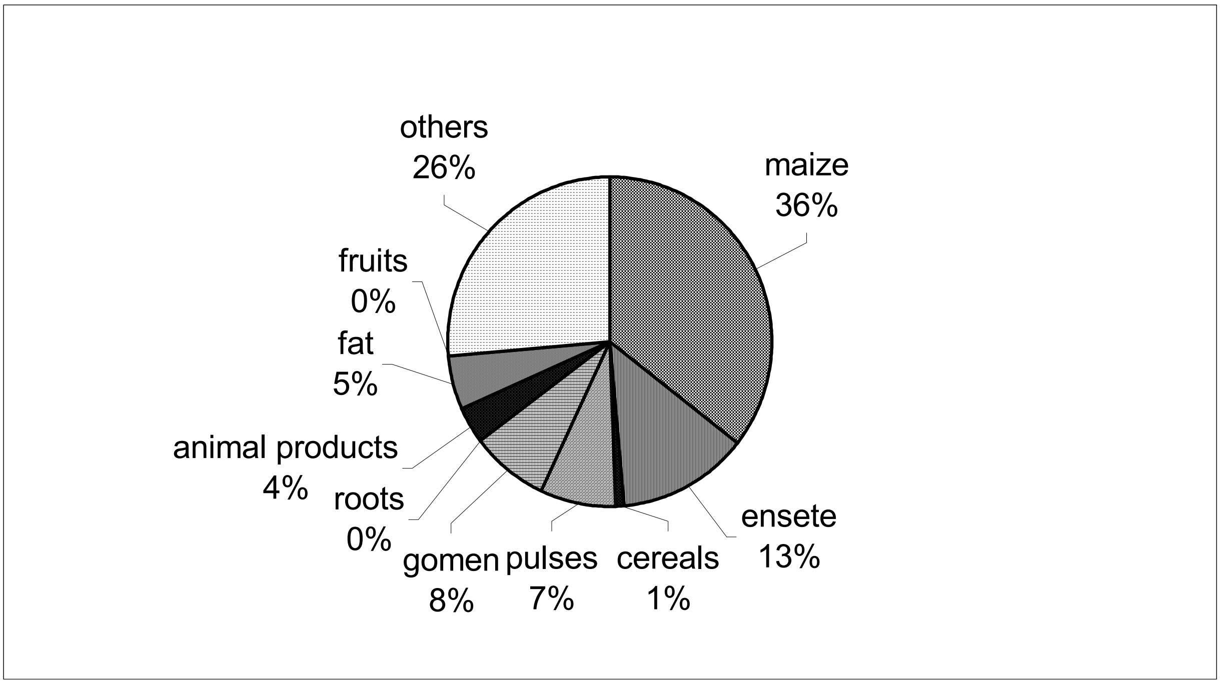

Figure 4 – 5: **Share of food expenditure for different foods in the pre-harvest season – oedematous group**

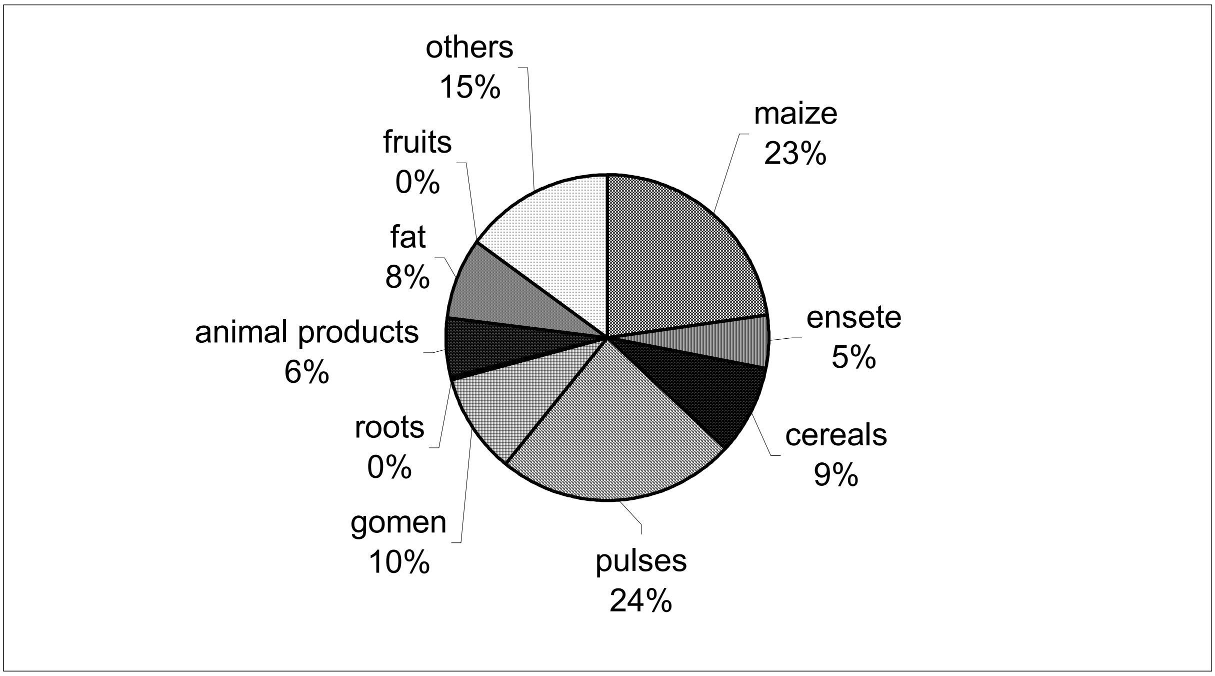

Figure 4 – 6: **Share of food expenditure for different foods in the coffee season – non-oedematous group**

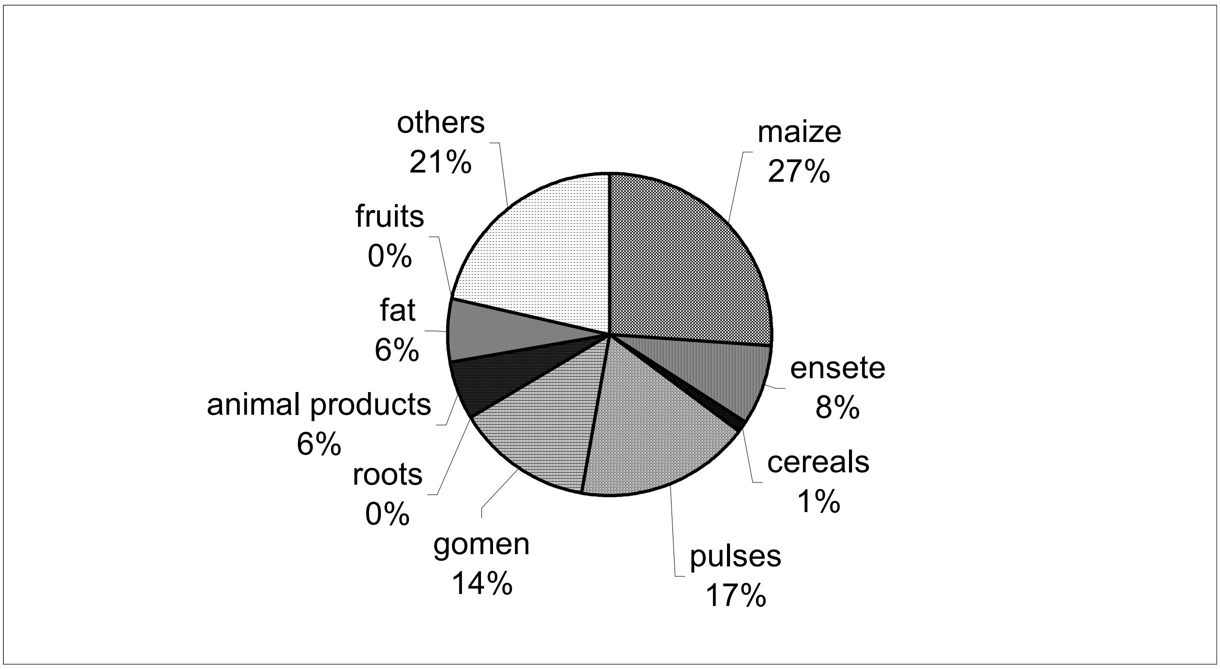

Figure 4 – 7: **Share of food expenditure for different foods in the coffee season – oedematous group**

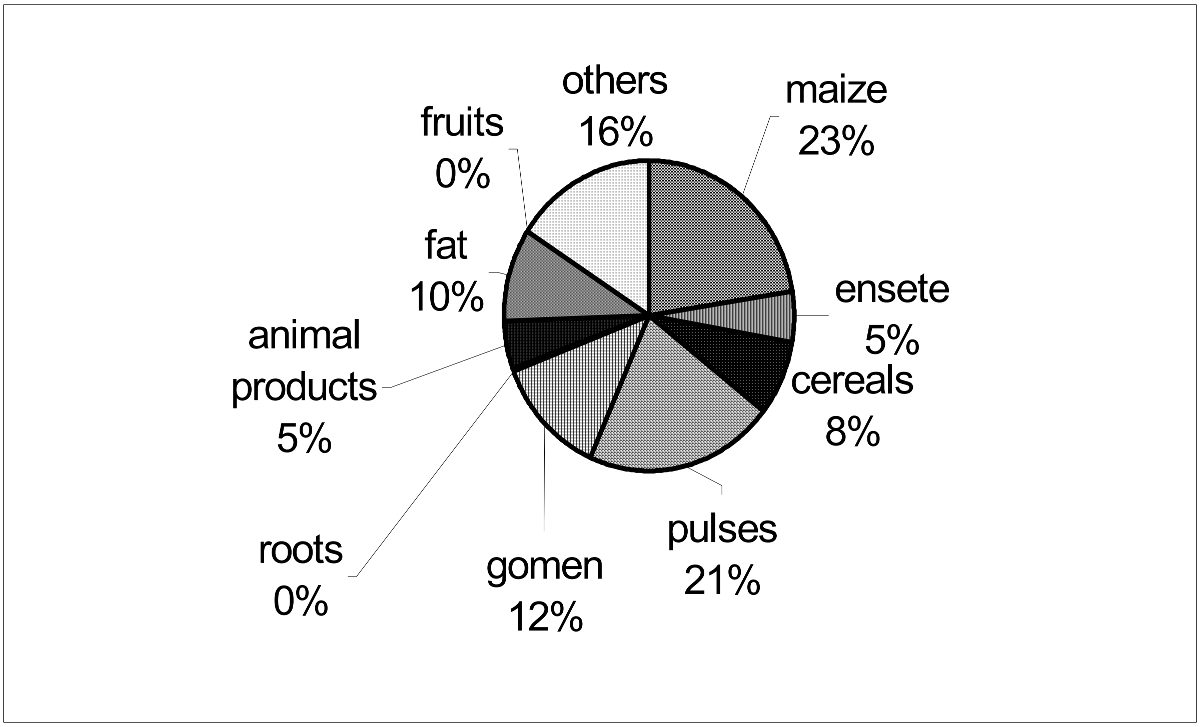

Figure 4 – 8: Share of food expenditure for different foods in the post-harvest season – non-oedematous group

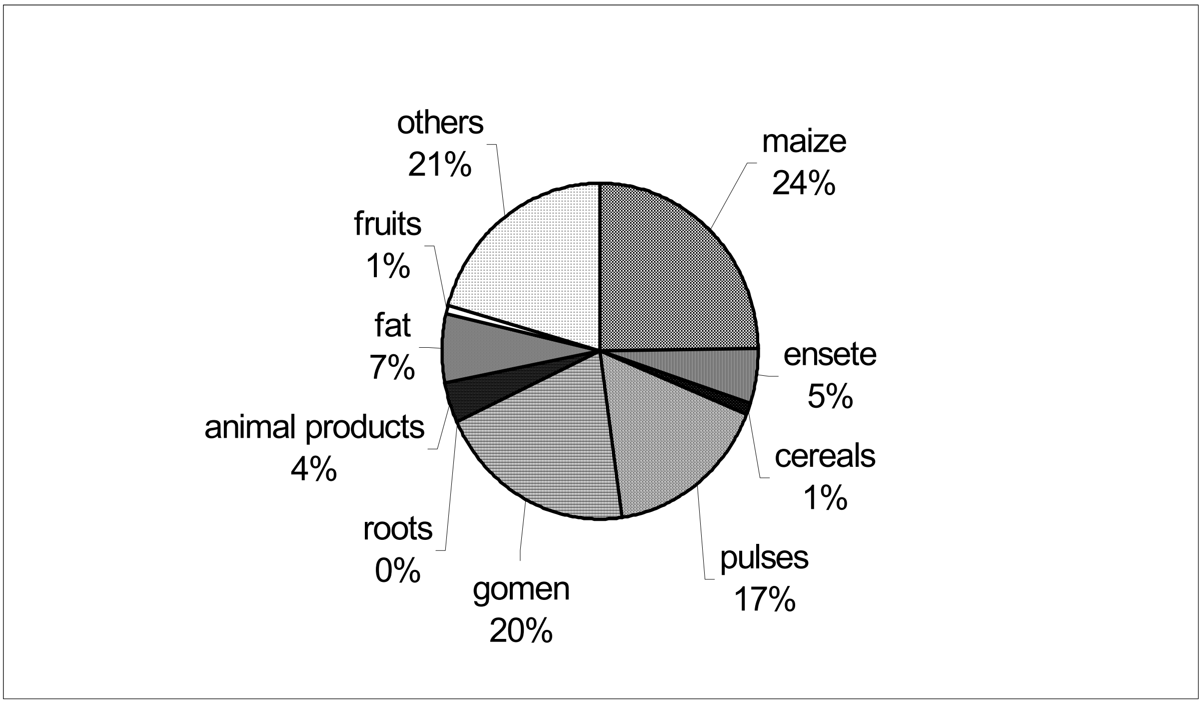

Figure 4 – 9: Share of food expenditure for different foods in the post-harvest season – oedematous group

4.4 Agricultural production and livestock ownership

When discussing the prevailing reasons for malnutrition in children, food security aspects in the households might play a significant role. To find out more about the diversity, amounts and usage of foods produced in the households, information about *agricultural products, livestock ownership and usage patterns* were obtained.

4.4.1 Method

The information about the above mentioned aspects was collected through a structured interview. The male head of household, (or in some cases a female head of household), was asked to estimate the amount of all agricultural foods acquired by the household over the preceding 4 months and how household members had used the food. Respondents were encouraged to report quantities using local measures, for example *ensete* products were estimated in “donkey rolls”, which is how people sell it on the local market. Later, all local measures were converted into kilograms. Other household members were encouraged to participate during the interview and often served to refresh the memory of the principal respondent.
Monthly data on lack of food of the households was collected by asking the head of household if during the preceding 4 months they had experienced a lack of food and if so what food was lacking.

4.4.2 Results

4.4.2.1 Agricultural products and usage pattern

Results are listed in Annex A 4-5.
The main plants cultivated in the Sidama zone are ***ensete***, also called the false banana, and coffee. *Ensete* is the main staple food. New *ensete* trees are normally planted every year in the post-coffee season. *Ensete* is available throughout the year and thus not subject to seasonal fluctuations. Coffee serves as a main source of income as the people rely heavily on the harvest of the coffee trees. Once the coffee trees are planted, normally no new trees are planted afterwards, so people wait for

the coffee harvest between August and November every year. Therefore *ensete* and coffee can be considered “permanent” plants.

Given the long growing season, most zones provide the opportunity to cultivate a wide variety of root, tuber and cash crops, of which the most important are coffee and *ensete*. During the study year both crops had suffered from diseases which had reduced yield and income. Coffee had suffered from coffee berry disease exacerbated by the reluctance of farmers to buy plant protection chemicals whilst the ensete crops had suffered from *ensete* bacterial wilt, a disease for which there is still no effective treatment or prevention procedures known. Maize is the most common cereal planted in this area during the rainy season, the harvest of which usually takes place between June and August. Some households plant other food crops like tubers and legumes.

Figure 4-10 shows a strong seasonal pattern of agricultural production, with *ensete* and bananas being the only plants nearly independent of seasonal influences. The biggest part of all farming households planted *ensete* and fed their family with the product during the whole year, with the marasmus group having the fewest farmers with *ensete* plantation. Annex A 4-5 shows that the control group had much higher *ensete* productivity throughout all seasons than the ex-PEM-groups. The differences between the groups were highly significant during the seasons from December to March and from April to July ($p= 0.0046$ and $p=0.0064$ respectively). The control group was even selling part of their harvest in each season, whereas the illness groups used their harvest almost exclusively for own consumption. There were important differences between the groups for the percentage of *ensete* sold in the pre-coffee and post-coffee season ($p=0.0002$ and $p=0.0574$ respectively).

Maize is the most frequently cultivated crop in the Sidama zone. The control group had the highest productivity compared to the ex-PEM-groups, with the farmers from the marasmus group having the smallest harvest. From August to November the control group had a maize harvest more than twice as high as the one of the marasmus group. In all groups the majority of the maize was used for own consumption. There was no home-grown maize available for any of the households from December to March.

Maize and *ensete* is mostly consumed together with the Ethiopian cabbage ***gomen*.**

Thus, *gomen* is the most common vegetable planted in gardens. The main harvest time for *gomen* is between April and July, but it can also be harvested in August and September. More than 75% of all households had a *gomen* harvest between April and July, but the harvest was higher in the control group (on average 66 kg compared to only 43 kg in the kwashiorkor and 41 kg in the marasmus group) (p=0.0546). The harvest was used exclusively for own consumption.

In addition to the production of *ensete* plants and maize the control group used their farm for planting beans and roots. In the pre-coffee season, many more households within the control group (66.7%) had a harvest from their planted **beans** than the kwashiorkor (40.4%) as well as the marasmus group (25%). The differences between the groups were significant (p=0.023) as well as between the control group and both of the separate illness groups (p<0.05). It was surprising to find that the kwashiorkor group sold on average about 10% of their harvest in the “hunger” season from April to July, whereas the other two groups were using the harvest exclusively for own consumption.

Roots were also planted in a higher number by the control farmers. In the main harvest season between April to July, more than half of the control group harvested root vegetables compared to only 10% to 20% of the illness groups. The differences between the groups were highly significant (p=0.0012) and also between the control and the kwashiorkor group (p<0.01). Moreover the average amount harvested was much higher in the control group than in the illness groups (on average 70 kg in the control group and 47.8 in the kwashiorkor group, 46.0 kg in the marasmus group). Although the kwashiorkor group had less harvest than the control group, they sold about 7% of their roots.

For farmers in this region **coffee** is the main source of income. Coffee was harvested in more than 65% of the households in all groups, but households of the kwashiorkor group had the strongest dependency on coffee (more than 80% had coffee harvest). The productivity of the coffee plants was higher in the control households, but the differences were not significant. During the season from August to November 45% to 50% of the harvest in all groups was sold. Those households who harvested coffee during the season of December to March (up to 17%) were even selling more than

50% of their coffee harvest and this especially in the two illness groups. The marasmus group sold more than 80% of the harvest.

Fruits make up an important part of the people's diet especially in the pre-harvest season. **Banana** trees have been commonly grown in Sidama for many years. About 80% of the households belonging to the control group grew bananas during the season between April to July compared to only half of the illness group. The differences between the groups were significant (p=0.0175). Also in the post-coffee season more households of the control group grew bananas (p=0.039). The harvest was measured in bunches which comprise approximately 70 to 100 bananas. On average, the control group harvested one bunch of bananas more than the other groups. Especially for the two illness groups the sale of bananas was an important income source, with the kwashiorkor group selling the majority of their harvest. Whereas the control group was selling their bananas primarily in the post-coffee season, for the illness groups it was an important income source throughout the year. The kwashiorkor group even sold about 60% of their banana harvest in the coffee season, compared to only about one third of the harvest in the control and marasmus group. Because of their high content of ß-Carotene, bananas are especially valued in this area to protect against Vitamin A deficiency and thus night blindness or blindness. In the kwashiorkor households, especially in the time between December and March where there were no other products in the garden, the majority of their bananas was sold to generate income.

Over the last 20 years it has become more common to plant **avocado** trees in Sidama. 30 years ago there were no avocado trees planted in this area until missionaries introduced them to the farmers (according to an interview with Dr. Johannes Olaffson, Director of Yirga Alem Hospital 1997, Norwegian Lutheran Mission). Normally the avocado trees can be harvested twice a year and the fruits are rich in fat and tocopherol. In a diet deficient in fat and foods rich in fat, the avocado plays a significant role in these people's diets. Avocados are provided as a snack, especially to children. Up to 30% of all observed households had avocado products during the year. The data show that especially the households of the kwashiorkor group sold up to 50% of their avocados to get additional income. In discussions with the families they said that avocados or other fruits cannot "fill the stomach of everybody in the family”. This was the reason why they sold it and used the money for buying more *kocho*, the bulky staple food in this region.

Other fruits, such as passion fruits, guavas, papayas and pineapples were harvested more often in control households and less often in the kwashiorkor households. The differences were significant (p=0.04) in the pre-coffee season. Moreover, in households with kwashiorkor children who harvested fruit, a significant portion was sold. But in all households fruits were not planted according to the agricultural capacity of this area.

To **summarise**: the control farmers had a higher diversity of foods planted on their fields and they also had higher productivity than the ex-PEM-groups. Especially in the “hunger seasons” the control farmers fed their families with beans and roots in addition to the staple food *ensete*. Farmers from the kwashiorkor group not only had significantly less variety and harvest than the control farmers, but in addition they sold significant parts of their roots, avocados, bananas and other fruits. There were no significant differences between the kwashiorkor group and the marasmus group with the exception of more farmers in the kwashiorkor group planting red kidney beans. The marasmus group sold less of their harvest.

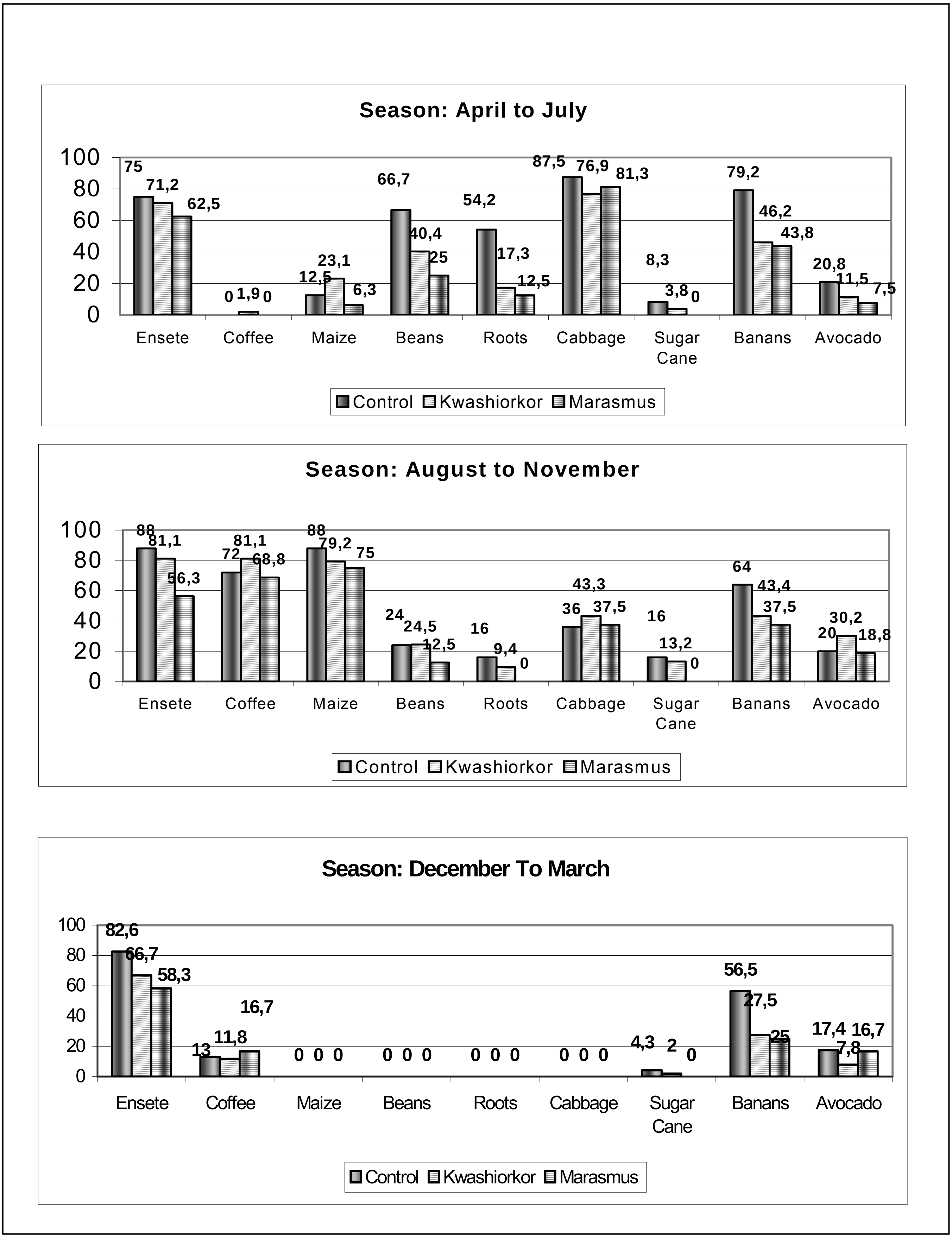

Figure 4 – 10 : **Part of households (in %) with harvest of different agricultural products during the seasons**

Oedematous versus non-oedematous

Concerning the comparison of agricultural pattern and usage between the oedematous and non-oedematous group the results are even clearer. Significant differences were only found in the pre-coffee season. For the following products the non-oedematous group had a significantly higher harvest: *ensete* (p=0.0068), *gomen* (p=0.0032) and roots (p=0.0059). In this season significantly fewer households of the oedematous group compared to the non-oedematous group had banana harvest (40% and 60% respectively). Moreover, the oedematous group sold a significantly higher extent of their fruit harvest in the pre-coffee season as well (p=0.032).

4.4.2.2 Livestock ownership, products of livestock and usage pattern

In Sidama the ownership of domestic animals, especially cows, is considered as a sign of the farmers' wealth. In case of illness, cows, sheep and goat serve as an important financial source for the household. Thus, animal husbandry contributes directly (food for the household) and indirectly (incomes from sales) to people's nutrition. Therefore, information on the ownership and usage pattern could be related to the availability of foods rich in animal protein, which is a significant source of the amino acids containing sulphur as well as antioxidants like zinc and selenium. In the context of the development of kwashiorkor it has to be examined, if in households with former kwashiorkor children less foods from animals were available.

Annex A 4–6 presents those households who were owners of working animals (donkey, oxen, and horse) and meat- or milk-producing animals. The number of animals was functioning as a means indicating the potential of the household to produce food of animal origin or income.

Concerning the **ownership of animal husbandry,** there was only a significant difference concerning the number of households possessing chicken (p=0.0296). Whereas 70% of all control households had chickens, only about 47% of the kwashiorkor households and about 33% of the marasmic households owned chickens. All together the marasmus group was the group with the lowest number of households owning domestic animals. More than 15% of the control and kwashiorkor groups

were the owners of goat or sheep. No single household of the marasmus group owned a sheep and only one household had goats.
Working animals like oxen and donkeys were commonly not in possession of the households in this sample.

Differences were especially seen in the **average number as well as the median of animals owned** by the households in the different groups. On average, households from the control group owned 3 cows, whereas those of the illness groups only possessed two cows. Also the median was higher in the control group (3 compared to 2 in both illness groups). Additionally, the average number of chickens was higher in the control group. The households in all groups rarely used their livestock for their own consumption, but instead kept it as a kind of “account” in case of illness, for sale or for use at celebrations. In the hunger season from April to July nearly no animals, with exception of chickens, were sold (mean and median was 0 in all groups) whereas in the coffee season some of the households sold cows, goats or sheep. In this time higher prices can be achieved for the animals at the market, since in the coffee season the demand for meat increases.

These results indicate that for the control households the availability of **products from animals** such as milk and eggs was most probably higher than in the two illness groups. This aspect was examined through the assessment of the number of eggs and litres of milk from cows in two seasons: from April to July and from August to November (Annex A 4–7).
About twice as many households of the control group compared to the ex-PEM-groups had milk producing cows. The average number of litres produced by the cows during the pre-harvest season was also importantly higher in those owned by the control group than in those belonging to the illness groups, with animals from the kwashiorkor group having the lowest productivity. In the coffee-season the animals in all groups produced more milk. During this season, about 80% of households in the control group had cows producing milk compared to only 35% of households in the kwashiorkor group and 44% of households in the marasmus group. Interestingly, the kwashiorkor group sold a much bigger part of the milk they collected from their cow(s) compared to the control and marasmus groups. This was specially the case in the hunger season from April to July. Whereas the control and marasmus group only

sold about 17% and 13% of their milk, the kwashiorkor group sold more than 40%. The differences between the groups were significant (p=0.026, Fishers two-tail exact test). In the coffee season less milk was sold in all groups, since then the main income came from the sale of coffee. But even in this season the kwashiorkor group sold more than twice as much of the milk produced than the control group. Also the marasmus group then sold up to 25% of the milk produced. The number of litres sold and consumed was different between the groups (p=0.042) in the pre-coffee season, with the kwashiorkor group selling the most milk. The underlying reason for the sale of milk was that milk was often not believed to be satisfactory for all household members. The cows' milk had a significant meaning for the nutrition of children. The milk will normally be produced as buttermilk. Mostly, it was given to the smallest child in the family and to the father. Children older than 5 years only rarely receive a cup of milk. In the case of the former kwashiorkor children they were mostly older than 5 years when they became oedematous. According to particpant observations in several families, the milk was preferably given to the breast-fed child. Some of the former marasmic children were still in the age of breastfeeding. Therefore, they were sometimes given cows milk in addition to mother's milk. This result will be discussed later with the results from the exact food weighing of the children (Chapter 5.2.2.2).

To **summarise**, the ex-PEM-groups had less foods available from domestic animal husbandry and from those households who had cows milk, the kwashiorkor households used a significant part of the milk for sale.

4.5 Families self assessment of their problems in daily life

To find out more details of the prevailing factors of PEM, especially kwashiorkor, it was intended to gain some knowledge on what people themselves think of their problems in daily life. In order to allow an estimation of the quantitative importance of some problems relevant questions were included in the standardised questionnaire. Heads of household and caregivers of the index children were asked separately. The questions were asked in two seasons: the pre-coffee season and the coffee-season. A maximum of three answers were allowed.

4.5.1 Head of household's self assessment of their problems

Figure 4-11 and Figure 4-12 portray the main perceived problems of heads of household in daily life in the pre-coffee and the coffee season. The main problem in all groups was a lack of cash money. This was stated by 100% of the heads of household from the marasmic children and from about 90% of those from kwashiorkor children in the pre-coffee season. Also about 67% of the control group stated a lack of money to be of major concern. The differences between the groups were significant (p=0.003). Moreover, shortage of money was mentioned as the main problem in all groups also in the coffee-season (Figure4-12). But the illness groups were much more concerned about this problem (significance between the groups p=0.008).

In the pre-coffee season the second most frequently stated problem by the illness groups was a lack of food. More than 50% in the kwashiorkor group and more than 65% in the marasmus group mentioned this as a main concern. Only 10% of heads of household from the control group complained about a lack of food. In the coffee season food was not stated as major concern, but also in this season about 20% of the heads of household from both illness groups suffered from a lack of food. Furthermore, a poor housing condition was of major concern for both illness groups, but more heads of household from the kwashiorkor group mentioned this as a main problem than those of the marasmus group in both seasons. Only one head of household from the control group stated a poor housing condition as a major concern in daily life in the pre-coffee season and only two in the coffee season. The differences between the answers given by the groups were significant in both seasons investigated (p=0.0001 in the pre-harvest season and p=0.02 in the coffee season).

For the control group the second most frequently stated serious problem in both seasons was a shortage of grazing land for the cows. The differences between the groups were significant ($p<0.01$ in both seasons). As mentioned above, more households from the control group were owners of cows and on average they possessed one more cow than the households of the illness groups. Thus, they were more dependent upon grazing land.

In the coffee-season a shortage of farmland was mentioned as a major problem in the illness groups, but especially the heads of household from the marasmus group were concerned (50% compared to 21% of the kwashiorkor group and only 13% in the control group). The differences were significant between the groups ($p=0.01$) and also the differences between the two illness groups were significant ($p<0.05$).

The occurrence of illnesses seemed to be a priority problem only in the homes of the illness groups. In both groups 22% of heads of household mentioned this problem to be of high priority in the coffee season. The differences between the groups were significant ($p=0.03$).

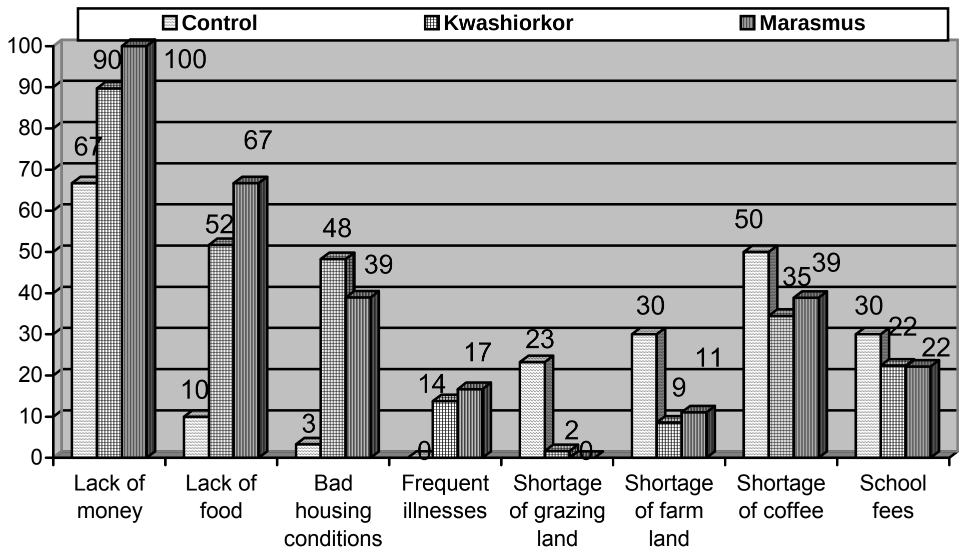

Figure 4 – 11: Head of household's self assessment of problems in daily life – pre-coffee season (%)

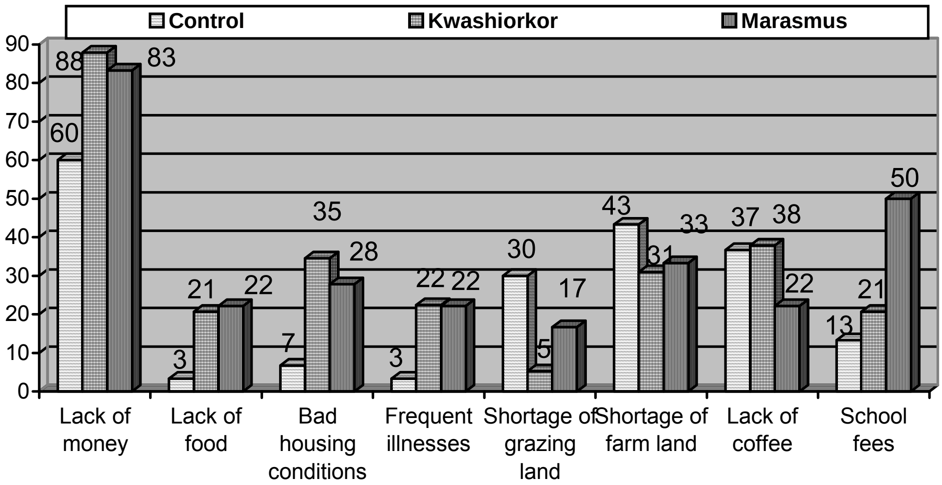

Figure 4 – 12: Head of household's self assessment of problems in daily life – coffee season (%)

4.5.2 Caregiver's self assessment of their problems in daily life

Since women take a different role in the household, especially as caregiver for children and housewife, other problems may be perceived. To understand their point of view, women were asked separately.

In the pre-coffee season the opinions of the caregivers were similar to those of the heads of household. The first problem was a lack of cash, but the illness groups were more concerned (differences between the groups were significant with $p=0.01$). About 50% of caregivers from the kwashiorkor children stated a lack of food as well as bad housing conditions as problems of highest concern. Food shortage was also a main problem for the caregivers of the marasmus group, but only 33% complained about a bad housing condition. The differences in the answers given between the groups were highly significant for both food shortage and bad housing condition ($p<0.001$). A lack of coffee was a main problem in all groups, since coffee is the main source of income in this region and they waited for the coffee harvest. For about 40% to 50% of caregivers this was of major concern. Strongly linked to a lack of coffee was a shortage of farming land. Because of the high population density in this region the size of farming land has been steadily decreasing in recent years. 22% of caregivers from the marasmus group and even 30% of the control group complained about a shortage of farmland. For the kwashiorkor group this was not a main problem. The differences between the groups were significant (p=0.03). The households from the kwashiorkor group seemed to be more affected from diseases. About 20% of the caregivers in this group mentioned the occurrence of illnesses to be of high concern. Some caregivers stated a too high workload (10% of the control group) or school fees as a main concern. The caregivers from the control group did not complain about food shortage or bad housing conditions. The last two differences between the answers given were significant (p<0.05).

In the coffee-season there were some significant differences between the illness groups. Especially for the caregivers of the kwashiorkor group a lack of money was of highest concern for nearly 90%. Only 56% of the caregivers of the marasmus group stated this problem, even less women than in the control group (73%). The differences between the groups were significant (p=0.01), and also the difference between the two illness groups (p<0.05). The second most frequently mentioned problem in the kwashiorkor group was a bad housing condition (41%). For the control as well as for the marasmus group this was not of major concern. The differences between the groups were highly significant (p=0.007).
For the marasmus group the second most frequently stated problem in the coffee season was a shortage of farmland (39%). Only 10% of caregivers from the kwashiorkor group mentioned this problem. The differences between all groups as well as between the marasmus and kwashiorkor group were significant (p<0.05). About one third of the caregivers of both illness groups mentioned a shortage of food as a main concern. This was no problem for the control group. The differences between the groups were highly significant (p=0.001).
Also the occurrence of diseases was an important problem for both illness groups (22% of the marasmus group and 26% of the kwashiorkor group mentioned this problem). The differences between the groups were significant (p=0.04).

The opinions about main problems in daily life of head of household and caregivers were quite similar. They underline the serious and widespread lack of money in all groups with the illness groups being especially concerned about this. Moreover both illness groups stated food shortage as a main concern, especially in the pre-coffee season. Besides these problems the kwashiorkor group also suffered from bad housing conditions. Independent from season, a lack of money, food shortage and bad housing conditions were stated as main the problems facing the kwashiorkor group. The marasmus group complained more about shortage of farming land. With the exception of a lack of money, the control group did not seem to be concerned with other big problems in their daily life. For some of those heads of household a lack of grazing land for the cows was of main concern.

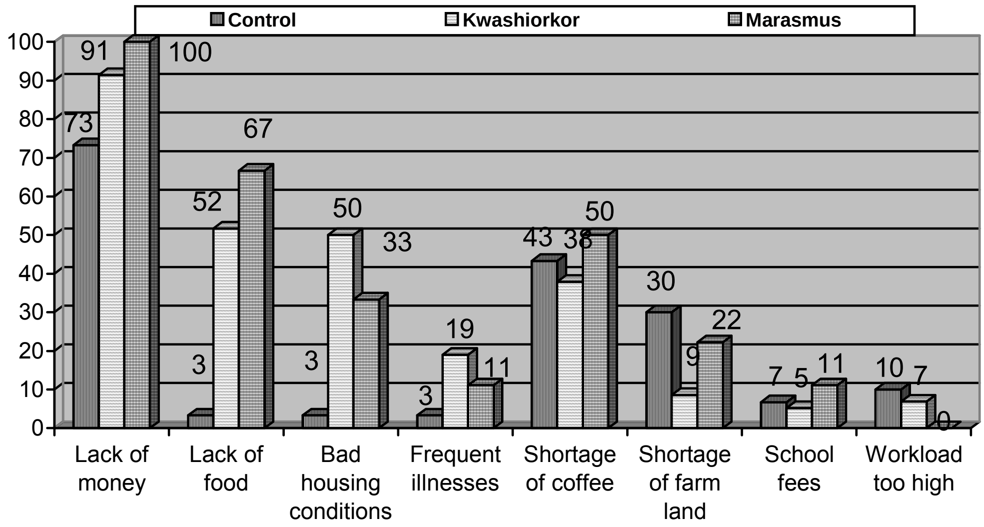

Figure 4 – 13: Caregiver's self assessment of problems in daily life – pre-coffee season (%)

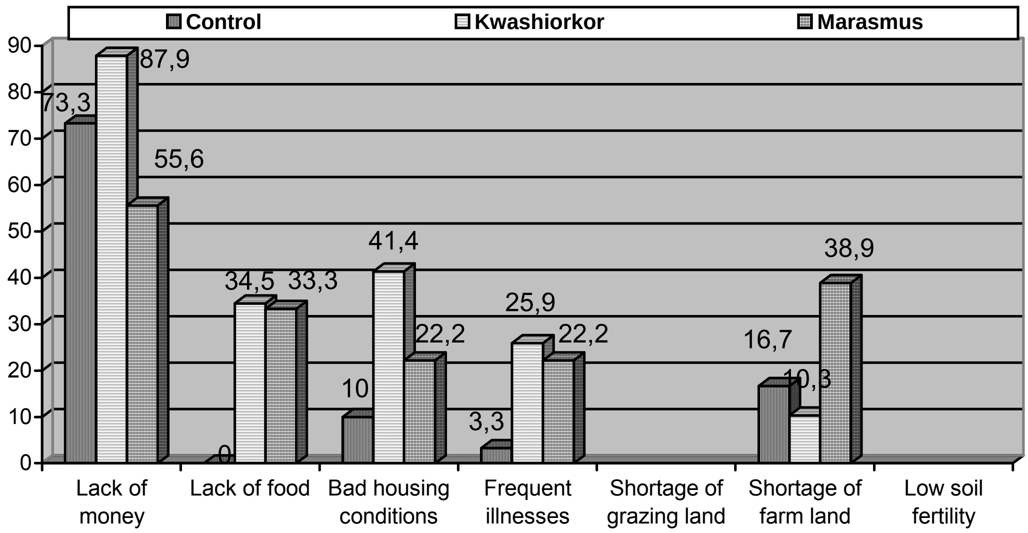

Figure 4 – 14: Caregiver's self assessment of problems in daily life –coffee season (%)

4.6 Food variety at the household level

4.6.1 Background and method

For a better insight into food availability at the household level, an assessment using food variety scores was conducted. Food variety scores quantify the number of different foods consumed, and are computed for a certain time period. It is postulated that it is advantageous to eat a variety of foods to improve nutrient adequacy, dilute possible toxicants, include a wider number of non-nutrient components of food in the diet, and to take into account the physico-chemical properties of foods (HUDGSON, JM 1993). Food variety, or dietary diversity scores have been used previously to demonstrate that greater dietary diversity is associated with better nutritional adequacy. A greater food variety has also been associated with improved health status.

One of the objectives of this study was to find out if there was a difference in food diversity in the households of the investigated groups: kwashiorkor, marasmus and control group and, moreover, prospective oedematous and non-oedematous group.
All foods consumed in the households, from home-grown to foods bought at the market were taken into consideration. Home-grown foods were counted separately from those bought at the market. If a food was consumed in the household a score of „one“ was given, otherwise zero. All foods consumed were finally summed together. There were no assumptions made about quantity or frequency of consumption. No additional score was given for larger serving sizes, or if a food was consumed more than once over the time period. Every home-produced food received a score of „one“. Those foods which scored „one“ were added together to obtain a food variety score for the food being produced at home during all seasons.

The same was done for **foods bought at the market**. All foods which scored „one“ were added together to obtain a food variety score for the foods from the market for each season separately. Finally all different foods consumed, either those produced at home or bought in addition on the market were added together to get the food variety score of **all foods consumed** during one season. If a home-grown food was consumed then a score of „one“ was given. If the same food was bought in addition on the market the score was still „one“.
The food variety score of „own production“ will show the use of the farmer’s land . The food variety score of foods bought at the „market“ gives information about what

different foods the investigated people bought at the market in addition to their own production. Finally the score for „all foods“ shows the food variety in the households and can give conclusion about nutrient adequacy and health outcomes of the households investigated.

Concerning the **foods produced** in the own household, only farmer-households were taken in consideration. For the pre-coffee and the coffee season products from animals (milk, eggs) and slaughtered animals from own production were also included in the calculation.

4.6.2 Results

Food variety in households with ex-PEM children compared to control children

There was a significant difference between all investigated groups for the number of **foods from own production** during the seasons April to July and December to March (p=0,000 for season April to July, p=0.016 for season December to March respectively). During the season from April to July the control group produced significantly more foods than the kwashiorkor group (p<0.001), and the marasmus group (p<0.01). There was no difference between the two illness groups (Figure 4-15).

During the season from August to November, the main harvest time, there was no significant difference between the groups concerning the number of foods produced even though the mean number was higher for the control group (Figure 4-15). During the season from December to March there was a highly significant difference between the control group and the kwashiorkor group (p=0.001) but no difference between the control and marasmus groups. This indicates that especially the control group overcame the pre-harvest time by growing other agricultural products on their farm with other agricultural products planted on their farm. The marasmus group had a higher diversity than the kwashiorkor group, especially during the season between December to March. The kwashiorkor group experienced a peak in production from August to November, the main coffee harvest time. In the side seasons they produced fewer products.

The food variety score for the **foods bought at the market (Figure 4-16)** were not different throughout all seasons for all groups. In Chapter 4.3.3.3 we learnt that especially in households with former kwashiorkor children the food bought at the market was unbalanced compared to the other two groups, especially the control group. The food variety score for foods bought at the market proves in addition that the kwashiorkor group bought on average less different foods at the market compared to the other groups.

The **food variety score for all foods available (Figure 4-17)** during the seasons shows differences between all investigated groups in season April to July ($p=0.0022$) and August to November ($p=0.0001$). From April to July the control group used more different foods than the kwashiorkor group as well as the marasmus group (control and kwashiorkor group: overall $p<0.01$; control and marasmus group: overall $p<0.01$). There was no difference between the two illness groups. For the season from August to November the food variety score for the control group was also significant higher than in both of the illness groups (control and kwashiorkor group: overall $p<0.05$; control and marasmus group: overall $p<0.05$).
For the season from December to March the food variety score of the control group was only significantly higher than that of the kwashiorkor group (overall $p<0.05$), but no difference was found between the control and the marasmus group. Throughout all seasons there was no significant difference between the two illness groups.
The results indicate that the control households had more different foods available since they were more successful on their farms. They produced a greater variety of foods compared to the two illness groups. Concerning the illness groups, especially in the season from December to March, the marasmus group had a higher food variety compared to the kwashiorkor group because it bought more foods at the market, whereas the kwashiorkor group did not show any variety of foods throughout the year. The kwashiorkor group was fully dependent on the harvest of the permanent foods of their farms: coffee and *ensete*. In addition to coffee and *ensete* they only plant maize and some Ethiopian cabbage: *gomen*. The same foods were additionally bought at the market. This result indicates that the kwashiorkor group relies fully on coffee and did not spend as much time on their farms as the control group to plant different produce.

Food variety in households with an oedematous and a non-oedematous child

To analyse the background of the development of kwashiorkor the food variety score for those households where an oedematous child was registered after hospital discharge compared to all those households where no oedematous child was registered was of special interest.

The analysis (Figure 4-18) indicates that in those households with an oedematous child after discharge from hospital during the study period of one year, significantly less foods (p=0.020) were **produced on the farm** than in the non-oedematous households in the season from April to July. In the coffee season from August to November the oedematous families bought (Figure 4-19) a highly significantly smaller number of **foods in the market** (p=0.0004) and obviously had significantly (p=0.017) less foods **available for consumption** during this season (Figure 4-20). Also, in the post-coffee season the total number of available foods was lower than in the healthy group (p=0.056, weakly significant).

For the pre-coffee and coffee seasons animal and home-grown products were included in the total number of foods available. According to this analysis, the median total number of foods in the pre-coffee season was 9 for the non-oedematous group and 7 for the oedematous group. In the non-oedematous group significantly more foods were available than in the oedematous group (p=0.0007). In the coffee season the median for total foods available was higher than in the pre-coffee season (median = 12 for the non-oedematous group and median =9 for the oedematous group), but especially in the non-oedematous group a quite high number of household consumed 14 foods and more. The oedematous group had significantly less foods available than the healthy group (p=0.002). The number of all foods throughout the season was higher (mean: 8.7, median: 9.0) in households with post-marasmic children than in households with a post-kwashiorkor child (mean:8.0, median:8.3).

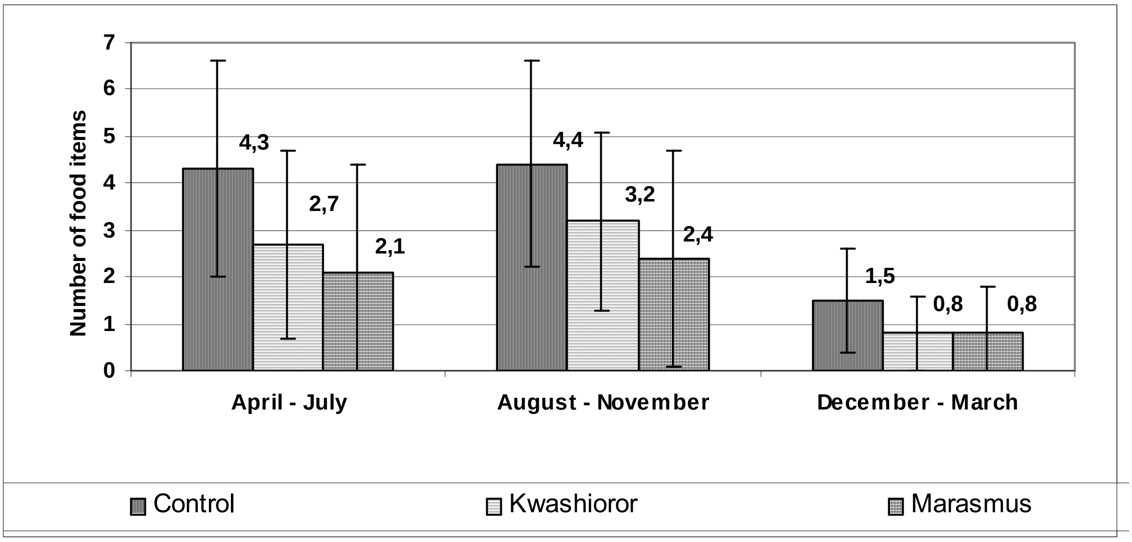

Figure 4 – 15: Number of foods from own production throughout the seasons in households with ex-PEM children and controls

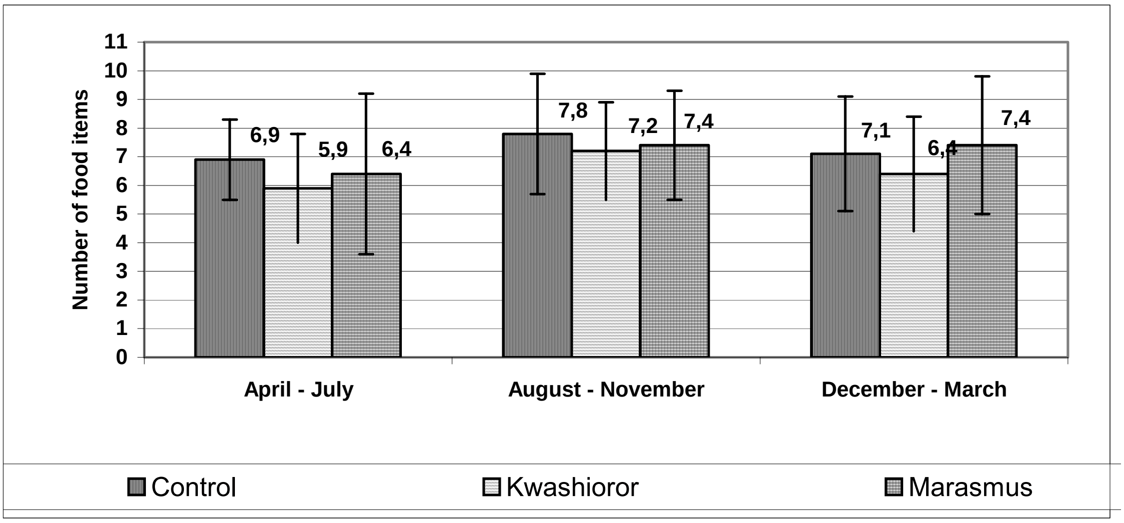

Figure 4 – 16: Number of foods bought at the market over the season in households with ex-PEM children and controls

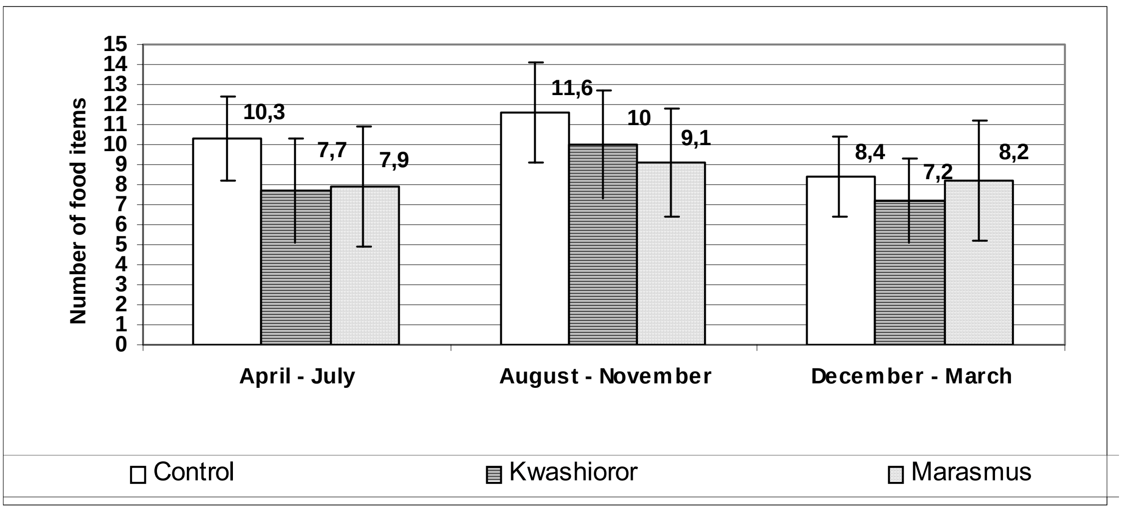

Figure 4 – 17: Number of all foods available throughout the seasons in households with ex-PEM children and controls

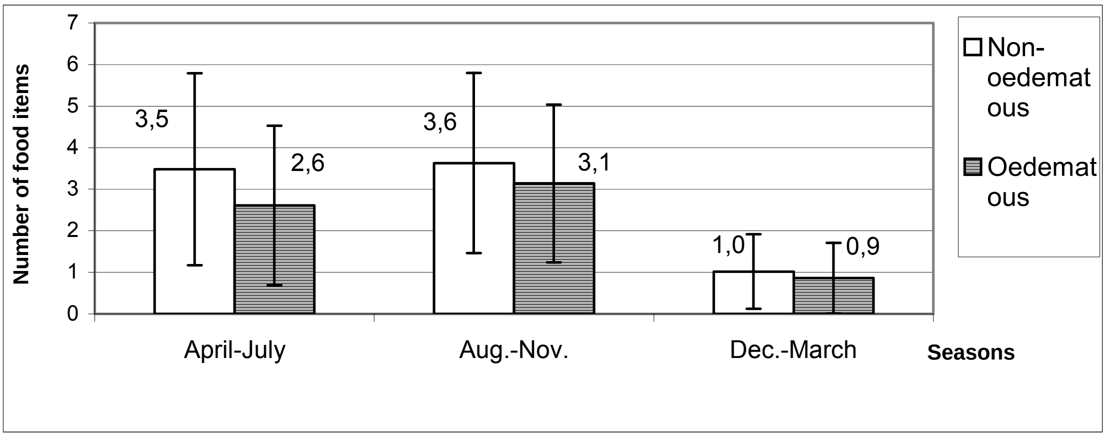

Figure 4 – 18: Number of foods from own production throughout the seasons in households with oedematous and non-oedematous children

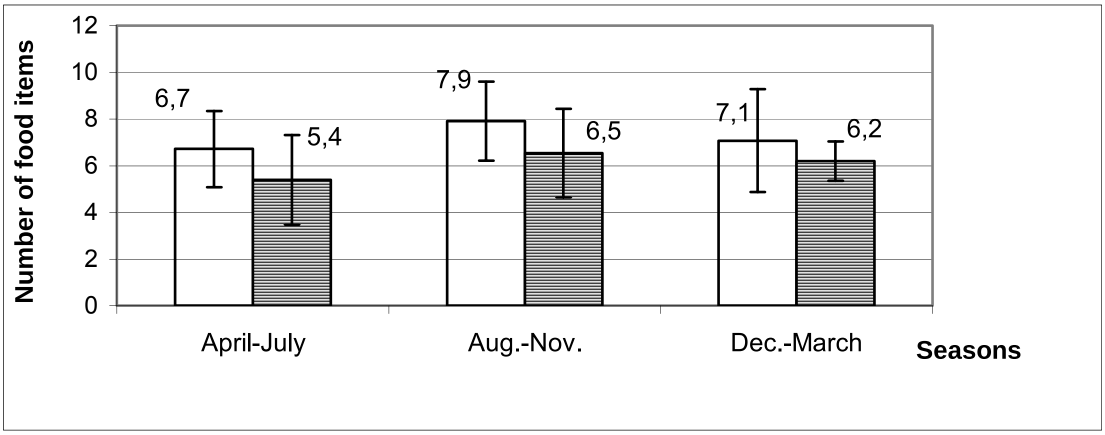

Figure 4 – 19: Number of foods bought at the market throughout the seasons in households with oedematous and non-oedematous children (caption see Figure 4 – 18)

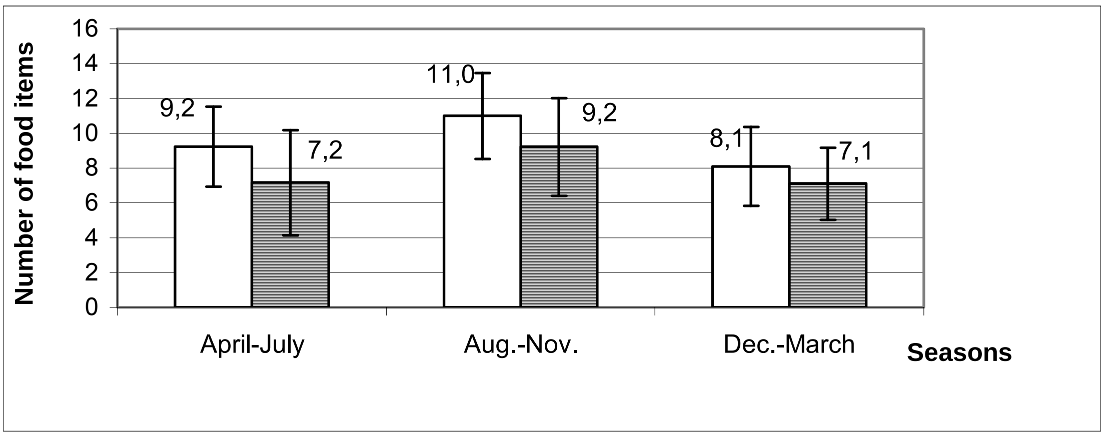

Figure 4 – 20: Number of foods available throughout the seasons in households with oedematous and non-oedematous children (caption see Figure 4 – 18)

4.7 Care for children as a determinant for the occurrence of nutritional oedema

4.7.1 Background

Addressing the problems of malnutrition requires an understanding of each step in the process from planting the field to the consumption of the ready food. The first step was analysed in the first chapters. In addition, this work is concerned with how care for young children affects their nutritional status, measured by the occurrence of nutritional oedema. In the following Chapter the study goes beyond analysis of the influence of care on the occurrence of nutritional oedema and examines the importance of care for child nutrition. It also analyses various issues concerning socio-economic factors the children were exposed to. For this cross tabulation and corresponding tests were performed.

Since care has a wide meaning first of all a definition is given to understand its meaning in the context of the occurrence of nutritional oedema. Care is the provision in the household and the community of time, attention and support to meet the physical, mental and social needs of the growing child and other household members (ICN 1992). According to ENGLE *et al.* (2000) care refers to the actions and practices of caregivers on a day-to-day basis that translate food, health care, and water and sanitation supplies into good growth and development of children. It includes behaviour such as feeding, sanitation and hygiene, home health practices, preparing food for children, and providing psychosocial support for development. Care requires resources in both skills and capabilities as well as economic resources. Some resources are easily recognised, such as education of the caregiver, but others are less often seen, including time and motivation of the caregiver and male family members for care, organisational resources such as child care centres, and the caregiver's ability to influence decisions about child care.
The significance of care has been articulated by UNICEF (UNICEF 1990). In the following essay by IFPRI (IFPRI 1997), detailed information about resources needed by the caregiver and different care practices are presented. Moreover it is pointed out that the child's behaviour or characteristics play a significant role in determining care.

Care is manifest in six types of activities practised by caregivers (most of the time the mother)

- Care for women, such as providing appropriate time or increased food intake during pregnancy
- Breast-feeding and feeding of young children
- Psychosocial stimulation of children and support for their development
- Food preparation and food storage practices
- Hygiene practices
- Care for children during illness and adoption of health seeking practices.

Whether care is provided depends on the availability of the resources at the household level: education and knowledge, health of the caregiver, time, autonomy and social support, as well as family economic resources.

The concept of "care" as a determinant of child nutrition is still a new field. To measure care is problematic because caregiver responses and practices vary from one culture to another (ENGLE 1997). Although many researchers have emphasised the importance of caregivers behaviour as a factor for the occurrence of kwashiorkor, up to today no intensive research has been done to measure the impact of care on the occurrence of kwashiorkor. This study will consider care as one determinant for the occurrence of nutritional oedema.

4.7.2 Methods

Measurement tools for assessing care included in this analysis were questionnaires, discussions with index households and neighbours, systematic observations in the care setting and detailed coding of ongoing sequences of interactions. Since behaviour that may appear strange to an outsider may be the norm in a particular culture, it is important to compare a caregiver with others in his or her culture. This is why in this study in addition to the former patient families the control families were also taken into analysis of care situations in the households.

Quantitatively care was measured through an "activity profile" where the time of all actions of caregiver was registered (Annex B). Since childcare should assess not only the caregiver's behaviour and practices, also the activities of the index child was registered during 24 hours. A coding system was used for all activities. Finally an "observation guide" (Annex B) was used to get information about the *quality of care* and the child's environment. During 24 hours the study personnel watched the caregiver, the index child as well as the other household members. The observation guide consisted of different subjects. The observing personnel filled in the questions answering "yes" when observed or "no" when not observed. The analysis was completed through discussions with caregivers, head of households, children and neighbours. A care index was created using the data from the observation guide. Results from the activity profile were separately analysed as well as the information on the education of the caregivers.

4.7.3 Results

4.7.3.1 Activity profile of caregiver and index child

The nutritional status of a child can be affected by the time devoted by the caregiver to child care activities, work, or activities besides child care (social activities etc.). Especially in the background of kwashiorkor it was hypothetically supposed that social or emotional deprivation or both are more often seen in households with a child suffering from nutritional oedema (GOODALL 1979, THOMAS 1981, VIRDIS *et al.* 1994). For this reason quantitative data was collected at the first visit after discharge from hospital. If time spent on childcare is to be used as an indicator of care, it should be measured by direct observations, which, in addition to getting accurate measures of time allocation, allows the specific childcare activities to be recorded. (ENGLE *et al.* 1997). The question is raised whether time spent can be used as an indicator for care. Is there a significant association between child welfare (occurrence of nutritional oedema) and time spent for the child?

The information on maternal and child daily time allocation was measured through a 24-hour stay in the family's houses. The mean duration of activities of the caregiver and the child are listed in Tables 4-6 and 4-7 after combining some of the categories in the following Tables. Results of significance of the spearman correlation are only listed when lying below 10%.

Table 4 – 6: Mean duration (hours) of activities of caregivers during one day, oedematous and non – oedematous group

Activities of caregiver	Duration in hours (Mean±SD)		Signifi-cance p=
	Oedematous	**Non-oed.**	
Housework (including cleaning of house, occupy-ing with poultry, working in the garden, fetching water and wood)	1.57 ±1.30	1.85±1.50	n.s.
Hygiene of caregiver and children	0.46 ±0.47	0.58±0.60	n.s.
Visit to the neighbours, conversations, resting	2.27±2.00	1.61±1.73	0.034
Preparation of meals	5.51 ±1.60	4.95±1.93	0.060
Meal time	1.86±0.95	2.07±1.06	
Occupation with index child	0.16 ±0.44 (Median =0)	0.60±0.86 (Median =0)	0.001
Occupation with sibling of index child	0.70±0.77	0.72±0.93	n.s.
Going to the market	0.83±1.09 (Median =0)	0.76±1.12 (Median =0)	n.s.
Income generating activities	0.25±1.30 (Median =0)	0.14±0.69 (Median =0)	n.s.
Sleeping	9.81±1.38	10.05±2.28	n.s.

Significance level $p<0.05$
n.s.: not significant

Table 4 – 7: Mean duration (hours) of activities of the index child during 24 hours - oedematous versus non-oedematous children

Activities of index child	Duration in hours (Mean±SD)		Significance p=
	Oedematous child	Non-oedematous child	
Sleeping	10.35 ± 1.08	10.97 ± 2.18	0.078
Passively sitting	6.75 ± 3.72	4.96± 3.39	0.008
Meal time	1.55 ± 1.33	1.39 ± 1.19k	n.s.
Staying alone at home	0.44±0.93 (Median =0)	0.47 ± 1.41 (Median =0)	n.s.
Hygiene	0.27 ± 0.37	0.35 ±0.46	n.s.
Talking with household members	0.57 ±1.32 (Median =0)	0.15 ± 0.64 (Median =0)	n.s.
Going to neighbours	0.20 ±0.59 (Median =0)	0.26 ±1.01 (Median =0)	n.s.
Playing with other child(ren)	2.92 ±2.67	4.20 ± 2.74	0.049
Housework	0.22 ± 0.75 (Median =0)	0.16 ± 0.76 (Median =0)	n.s.
Going outside the house with parent	0.19 ±0.58 (Median =0)	0.43 ±1.00 (Median =0)	n.s.

Significance level $p<0.05$; n.s.: not significant

The data (Table 4-6) clearly show that women with an oedematous child spent on average more time outside the house without the observed child. They spent significantly less time with the index child compared to the women of the healthy group (10 minutes and 36 minutes, respectively). On the other hand they spent longer time with resting, conversations, visiting neighbours or taking part at other social activities without the child, which might lead to neglect of the child. Also the meal times of those caregivers were not as long as they were in the healthy group. It was registered that the caregivers of oedematous children neglected their child in different ways: for example they were not ensuring their child ate enough or really finished the food. For example, if the child did not have any appetite to finish the food, older children or even animals ate the food when the child was not controlled. On the other hand the oedematous child spent on average a longer time for eating than the non-

oedematous child. From observations it was concluded that most common the reason for this was a lack of appetite.
Another factor reflecting the length of time the caregiver did not occupy with the child, was the time spent for income generating activities. The caregivers of the illness group took on average more time for those activities, even though the median in both groups was zero. Observations were that on most occasions the child was left alone when the caregiver left the house with nobody as a substitute caregiver. In most cases the child had nothing to play with, so that he/she lacked stimulation from the environment.

The time spent by the caregiver of the oedematous child on housework and hygiene was much less than in the control group. This confirms observations in the houses that the index child was not as clean as he/she should be. Also less care was taken for cleaning the house and dishes properly, so children had more contact with animals in the house and a dirty surrounding. Only the preparation of the meal took longer time (p=0.06) in families with an oedematous child. The problem was that the cooking process was rather unorganised. Observations in the houses clearly showed, that the women not only used wet wood for cooking, which took a much longer time to heat the stove, but also did not clean the cooking dishes during the daytime. Finally, having only one petroleum lamp for the whole house made it difficult to clean the dishes properly because of the darkness.

Observations and activity profile of the index child (Table 4-7) show that oedematous children spent on average many more hours a day sitting passively without playing or talking to other persons compared to the control group (6.75 hours and 4.96 hours respectively, p=0.008). In addition, they stayed alone in the house for about 0.45 hours. Often when the caregivers left the house, they took their child which still was breastfed with them. In summary, the oedematous children were not actively involved in household activities for about 7 hours a day compared to the control group children with around 5 hours. The oedematous children were playing for only 2.92 hours compared to 4.96 hours the control children were playing with other children (p=0.049). During 24 hours the oedematous children slept less than the control children (p=0.078).

4.7.3.2 Care index: index creation and results

Out of a list of variables different indices were created concerning the following subjects with direct connection to child care resources, practices and behaviour: hygiene, household organisation, problems prevailing in the household, behaviour of caregiver towards index child, behaviour of caregiver towards prevention of diseases of children and knowledge of caregiver towards child feeding. The different indices were formed with the following scoring system:
With exception of the hygiene index, all other indices were constructed through summing up the scores given for each variable. In case a question could be answered with “yes” and was considered as a positive behaviour a score of +1 was given, the same variable which got an answer “no” and which was seen as a negative practice was allocated a score of 0. On the other hand, variables observed which were supposed to be a bad practice were scored with -1 when answered with “yes”, if the same variable was answered with “no” a score of 0 was given. For example: In case the drinking water was pure a score of +1 was allocated, whereas a score of 0 was given, if the water was not pure. If it was observed that there were “flies in the house“, so answered with “yes”, a score of –1 was given, since flies were possible transmitters of diseases. If there were no flies a score of 0 was given. The variable “bed-facilities“ was analysed in the following way: if the bed facilities were good a score of +1 was given, in case they were classified as medium it was scored with 0 and bad bed facilities were graded -1.

Observations were carried out by a trained survey team. All members were from Sidama zone and familiar with daily life and problems of the people. Some of the variables were subjectively classified. The water quality for example was not controlled in a laboratory but was classified as “bad” when the pot storing water was dirty.

The following indices were combined in the final care index. The variables, which made up the different indices and the scores allocated, are listed in Annex A 4-9.

Index of household organisation

As observed in pre-tests and confirmed later during the study, there was a strong sense of disorganisation in many households. In this area the beds in most houses were constructed from local material, mainly dried false banana leaves. Because of the humidity generated by these leaves the bed material needs to be brought out into the sun during day time. When they get old, they must be changed in order to prevent insects. The staff classified households according to bad, medium, or good bed facilities. In addition, a lack of blankets for sleeping was observed . Since it gets quite cold in this region during night time, it is important to have enough blankets for protection against ARI (Acute Respiratory Infections). The risk of diseases was also higher if the house was leaking. In some households no attempt was made to repair the house in this case. Moreover, it was a question of organisation whether the wood for cooking was dried enough in the sun to be able to start the cooking process. Variables used to build the household organisation index are listed in Annex A 4-9.

Index of personal problems perceiving in the households

Observations and discussions before the start of the survey indicated strong personal problems in the households of PEM children. Several personal problems in the households turned out to be problematic for the entire family e.g. if the householder was drinking alcohol or smoking. When the head of household got ill, it was especially critical for the entire family since income fell during this time. A lack of good social contacts might be a consequence. Another indicator for a problematic situation of the family is a substitute person for one of the parents. When there is a divorce or death of one of the parents the risk of a lack of childcare is higher (THOMAS 1981). Frequent quarrels and especially financial problems may have negative effects on the child.

Index of behaviour of caregiver towards the index child:

The behaviour of the caregiver has great effect on the well-being of a child (THOMAS 1981, ENGLE 1997). In this study it was observed whether the caregiver controlled the child's eating and hygiene and if she engaged herself with the child. The observers watched if the caregiver had a stronger preference for any other child(ren) or if the index child was neglected. The child was classified as neglected if the caregiver did not control, talk to or give any attention to the child. There was also not enough care if the caregiver was too actively occupied with other activities or, on the contrary, if she did not use the time for childcare in being too inactive. During breastfeeding a mother gives special attention to a child. In case the caregiver breastfed another child (mostly the sibling) a score of –1 was allocated since less time remained for the index child. In case the caregiver was ill, less time could be spent for childcare, so a score of –1 was allocated.

Health prevention index

Good caring practice also relates to the use of health care services. Because of this fact, caregivers who brought their index child for vaccination, used health care centres and gave colostrum for immunisation got a score of +1 for each of these positive behaviours. It has to be taken into consideration that these women did not have a vaccination paper, so the mother's answers could not be proved. Also it was only asked if the caregivers used health centres whereas discussions with mothers showed that many of them used the services only very irregularly or too late.

Knowledge index

Cultural beliefs and a lack of knowledge about infant feeding and weaning can lead to malnutrition (ENGLE 1997). The purpose of a knowledge index, therefore, is to illustrate knowledge of caregivers about the following issues:

Initiation of breast-feeding, colostrum:

The delay of breast-feeding proved to be the most important indicator of subsequent nutritional problems (RANGE *et al.* 1997). In Ethiopia breast-feeding is a universal practice. However, even educated mothers usually discard colostrum. It is a strong belief in Ethiopia, as it is also in other cultures (REISSLAND and BURGHART 1988, BLANCHET 1984, MC DONALD 1987, MC GILVRAY 1982 in REISSLAND and BURGHART 1988), that colostrum is highly undesirable. Colostrum is a high-density, low volume milk feed containing more protein, fat-soluble vitamins and more of some minerals compared later milk. It is so high in immunoglobulins and a host of other protective factors that it could be described as the first immunization of a child. It acts as a modulator of infant development (WHO-BULLETIN 1989). In this study a score of +1 was allocated to the knowledge index if mothers gave colostrum to their baby. In cases where colostrum was not given to the child a score of 0 was graded.

Initiation of herbs/unboiled water:

Pre-lacteal feeds of herb teas given in the first days postpartum and sometimes up to the end of the first year is widely practised in Sidama. The current recommendations on infant feeding generally include a period of exclusive breast-feeding for the first 3-4 months of life (PRENTICE 1991). In case unboiled water was not given to the child shortly after birth a score of 1 was graded, in case unboiled water was given to the babies a score of 0 was given.

In case mothers gave their children a tea made from herbs, called *ameza*, from the first day of life until the 4th month a score of –1 was graded for the knowledge index. It was recognised as a negative behaviour since some people buy *ameza* from traditional healers where the preparation is not known, and some people prepare the tea at home after cooking, so the tea might stand for several days without being (re)-heated or it may be served in a dirty cup. If it was given later than the age of 4 months, a score of 0 was allocated.

Quality of drinking water:
In case the drinking water was pure a score of +1 was allocated, whereas a score of 0 was given if the water was not pure. The survey team subjectively checked the water quality without it being analytically checked in a laboratory. Pure water quality was checked through the quality of the storing pots.

Duration of breast-feeding:
In Ethiopia breast milk, together with gruel, is generally continued to be given until about the end of the second year, sometimes even longer (MC LAREN1976). In case the mother only breast-fed the index child for 6 months a score of 0 was given. In this case it can be supposed that some negative events happened like an illness of mother or child. In case the index child was breastfed for more than 6 month a score of +1 was given.

Reason for termination of breast-feeding:
In a number of studies, the common reason for cessation of breast-feeding is another pregnancy (HARRISON *et al.* 1993, ALEDOM 1991a, 1991b, COMINSKY, MHLOYI and EWBANK 1993). The following scoring system was formed concerning this special investigation: sick mother, separation of the parents etc. was given the score of –

1, since in the background of malnutrition these factors could lead to a negative caring behaviour for the index child. If the child did not like to drink breast milk anymore or a new pregnancy was the reason for termination of breast-feeding, a score of 0 was given.

Complementary feeding:

Beliefs regarding complementary feeding have implications for child nutrition, since the age at which children are reported to be most vulnerable to growth faltering is the period between 6 and 18 months, which is the period of transition between breast milk and solid food (ENGLE *et al.* 1997). Timing as well as the type of weaning food have strong influences on the nutritional status of the child.

In addition many food taboos may limit the types of foods that can be offered. This means that children may not receive adequate amounts of protein- and micro-nutrient rich foods until they are around 18 months of age. In this study the duration of weaning as well as the different foods given as weaning food were included in the knowledge index of the women. In case the index child got family food within less than 6 months after introduction of the first food (including herbs given) a score of 0 was given. In case the weaning period was 6 months or longer a score of +1 was allocated. In Sidama the family food normally consists of *kocho* and *gomen*. The *kocho* is rather rough to eat and has a very low energy density. So, it is advisable to have a weaning period of at least 6 months where the children should get local pap made from cereals.

The number of different foods is one indicator of the nutrient intake of a person (SHIMBO 1994). Since the food prepared for the children in Sidama doesn't have a big variety, each different food given to the child can be seen as positive behaviour. Therefore, in this analysis each food given as weaning food was allocated a score of +1 e.g. if a child got 4 different foods for weaning, a final score of +4 was given.

Hygiene index

Since bad hygiene cannot be supposed to be a direct determinant for the occurrence of nutritional oedema, all variables of the hygiene index were first analysed to have a relation to the occurrence of diarrhoea. Finally, the hygiene index was formed through weighing scores. Those variables having no significant relation to the occurrence of diarrhoea ($p>0.10$) got a weight of 0.5. If a variable had a significance level between p=5% and p=10 %, a weight of +1 was given. A variable with a significant relationship ($p<0.05$) to the occurrence of diarrhoea was weighted with +2, and a highly significant relation to the occurrence of diarrhoea ($p<0.01$) was weighted with +3. Pearson qui-squared and Fishers exact tests were used for this analysis. The original variables multiplied with the factors described above were summed to form the hygiene index.

Results of variables included in the hygiene factor and their relevance (expressed in significance level) to the occurrence of diarrhoea are presented in Annex A 4**–8**.

Results of the Care Index

Annex A 4–9 informs about the scoring system used to grade each variable and main descriptive statistics for each of the variables included in the different indices, which formed the care index.

The means, medians, minimum and maximum values of the scores from the individual indices are shown for the oedematous and non-oedematous children in Table 4-8, and for the classification done at admission (ex-PEM children and control) in Table 4-9

Table 4 – 8: Mean, SD, median, minimum and maximum of indices concerning the care of children, non-oedematous and oedematous group

Indices / Groups	Household organisation	Problems	Behaviour of caregiver to child	Health prevention	Knowledge of care giver	Hygiene in the household	Care Index
Non–oed.							
Mean	-1.2	-0.3	0.4	1.8	7.2	12.4	22.4
SD	2.4	1.6	2.8	1.0	2.5	4.8	12.9
Median	0.0	1.0	2.0	2.0	8.0	14.5	27.0
Minimum	-6.0	-5.0	-5.0	0.0	1.0	-3.0	-8.0
Maximum	1.0	1.0	4.0	3.0	12.0	17.5	39.5
Oedematous							
Mean	-3.7	-1.1	-2.2	1.6	6.0	7.5	7.3
SD	2.1	1.6	2.3	0.8	1.9	6.3	10.8
Median	-4.0	-1.0	-3.0	2.0	6.0	9.0	8.5
Minimum	-6.0	-4.0	-5.0	0.0	2.0	-5.0	-12.5
Maximum	1.0	1.0	3.0	3.0	9.0	16.5	29.0
Significance level P =	0.000	0.007	0.000	n.s.	0.015	0.000	0.000

Table 4 – 9: Mean, SD, median, minimum and maximum of indices concerning the care of children, ex-PEM groups and control

Indices / Groups	Household organisation	Problems	Behaviour of caregiver to child	Health prevention	Knowledge of care giver	Hygiene in the household	Care Index
Control							
Mean	0.5	1.0	2.3	1.9	8.3	14.8	32.0
SD	1.3	0.2	1.4	0.9	1.9	2.2	6.1
Median	1.0	1.0	2.0	2.0	8.5	15.5	33.5
Minimum	-5.0	0.0	-4.0	0.0	3.0	8.5	5.5
Maximum	1.0	1.0	4.0	3.0	11.0	17.0	39.5
Kwashiorkor							
Mean	-3.3	-1.1	-2.1	1.5	6.0	8.8	10.2
SD	2.1	1.6	2.4	0.9	2.3	6.1	11.3
Median	-4.0	-1.0	-3.0	2.0	6.0	9.5	10.5
Minimum	-6.0	-5.0	-5.0	0.0	1.0	-5.0	-12.5
Maximum	1.0	1.0	4.0	3.0	12.0	17.5	29.0
Marasmus							
Mean	-2.4	-1.4	-0.2	2.0	6.7	10.2	14.8
SD	2.7	1.6	2.5	1.0	2.4	6.1	13.5
Median	-2.5	-1.5	-1.0	2.0	7.0	12.5	13.0
Minimum	-6.0	-4.0	-4.0	0.0	2.0	-0.5	-9.5
Maximum	1.0	1.0	4.0	3.0	11.0	16.5	36.5
Significance p=	0.000	0.000	0.000	n.s.	0.002	0.000	0.000

Index of household organisation and personnel problems perceiving in the households

The disorganisation of the household was shown in a striking manner by the results of this study. All measured variables belonging to this index were significantly different for the groups. In families where children became oedematous the parents did not leave the wood for cooking for long enough in the sun during daytime unlike the controls. They started to search for wood shortly before cooking, which was then, especially in the rainy season, wet. It finally took a very long time to prepare the fire for cooking. In addition, the house was full of smoke, since the fire was inside the house. Most children sat directly beside the fire so that they breathed in the smoke. Nearly 90% of the women started to prepare the food too late. Also, no efforts were made to fix the houses properly so that they were very cold during night-time and rain could enter easily. The study staff confirmed the dramatically bad housing conditions in those households during their experience of staying overnight. It would have been possible to fix the houses with mud and other natural materials at no cost, but in most cases no time was invested for this purpose. Moreover the problem increased, since more than 70% of the households lacked blankets for sleeping. No income was invested in these.

Personal problems in the household affected proper care for the well being of the child. Especially caregivers in the oedematous group complained about financial problems. As can be seen in Annex A 4–9 a large proportion of the households were in a difficult social situation. Often the head of household was a drinker, smoker or ill. Nearly 30% of the caregivers from the oedematous group were living without a husband in the house. The differences between oedematous and non-oedematous group was significant ($p<0.05$). All of these problems might effect the financial situation of the household. As observations in the houses confirmed, an important chunk of income was used for alcohol, cigarettes or other drugs. As mentioned above, in the kwashiorkor group expenditures for food were significant lower than in the other groups, even though the income was no higher. The above mentioned problems in these families could explain part of this phenomenon.

The differences between the “organisation of the household” and “problem”- indices were highly significant between the oedematous and the non-oedematous households but also when the sample was divided into the ex-PEM groups and the controls. Anyway, the differences between the ex-PEM groups (kwashiorkor and marasmus) were not significant meaning that households from both groups had deficits in organising the household as well as tremendous problems.

Behaviour of caregiver towards the index child

Results from behaviour index reflecting the behaviour of caregiver towards the index child show that children in the oedematous group were neglected. The caregivers of oedematous children did not succeed to provide enough care for the well being of their child. They neither checked if the child's hands were clean before eating, nor did they ask the child to finish the food when they had no appetite. For 73% of the caregivers in the oedematous group it was concluded that there was no supervision at all for their child during the whole day, compared to 38% in the healthy group. During daytime the caregivers spent much less time with their child compared to women of the comparing group. More than twice as many women from the illness group were classified as being too inactive compared to the women in the healthy group. This might be because the caregiver was ill, gave more attention to the breastfeeding child (70% of the women had a younger child which had to be breastfed) or was not interested in the child. The differences between the "behaviour index" for both investigated groups (oedematous and non-oedematous, ex-PEM and controls) were highly significant (Table 4-8 and Table 4-9).

Health prevention index

The results show that in Sidama most of the mothers discard colostrum. Only about one third of each group gave the colostrum to their child. Although about 80 % of the caregivers mentioned they use health services, significantly more children from the healthy group were immunised. Health services were used only in case of severe diseases. The Health prevention index was not significantly different between the investigated groups.

Knowledge of caregiver

The knowledge concerning child nutrition was less than ideal, especially in the illness group. Most women did not know the special meaning of colostrum for the health of their child. More than three-quarters of the women discarded the colostrum. Instead of this, around 70% in both groups gave their child a concoction made from different herbs, plants and water, called *ameza,* during the first 4 months. *Ameza* was given in the belief that it protects against stomach pain and immunises the child. The delay of breast-feeding after birth is proven to be the most important indicator of subsequent nutritional problems. (AGARWAL 2000). The danger of diarrhoea episodes increases with giving fluids to the child. In the study sample, about 25% of the caregivers from non-oedematous children gave water to the baby as a fluid and 36% of caregivers from the oedematous group gave water which was not even boiled.

Giving breast-milk is generally continued in Ethiopia until about the end of the second year sometimes even longer (MC LAREN 1976). Prolonged breast-feeding is observed specially in areas where milk is scarce. In this sample nearly all mothers breast-fed their babies for more than 6 months. The reason for stopping to give breast-milk was different in the two investigated groups. More than 80% of caregivers from the oedematous group stopped breast-feeding because of reasons such as illness of the mother, separation of the parents or the mother died. In the non-oedematous group a much greater proportion of mothers continued breast-feeding until a new pregnancy. The average duration in both groups was 24 months.

Moreover, the oedematous group started to give weaning food later than the healthy group (6.2 and 5.7 months, respectively). The weaning period for most children was more than 6 months.

Normally in Ethiopia milk, if available, and cereal gruel are offered as weaning food (TADDESSE 1983). The weaning food is very much related to the availability of milk or its products, which varies greatly from family to family. This is shown in a striking manner by the results of this study. It was significant (p=0.025) that more children who became oedematous after discharge compared to the non-oedematous children did not receive milk as weaning food (46% and 25% respectively), but 21% of the caregivers in the oedematous group compared to only 10% of the caregivers of the healthy group started to give *ensete* as one of the first foods in the weaning period. *Ensete* belongs to the main starchy food in the family dish. Normally, *ensete* will be avoided as weaning food (MUELLER 2002), but in these families there was a lack of other food, especially milk.

This result is also reflected in the score of the number of foods given during weaning. Whereas in the healthy group the children received on average 3.8 different foods beside breast-milk, only 3.0 foods were given to the oedematous children. As mentioned above, the food lacking was in most cases, milk. The differences between the investigated groups concerning the knowledge index were significant (Table 4-8 and Table 4-9).

Hygiene

The hygiene index was significantly different between the investigated groups according to the clinical classification, as well as according to the classification after discharge from hospital (both p=0.000) (Table 4-8 and Table 4-9).The median for the control group was 15.5 compared to 9.5 in the kwashiorkor and 12.5 in the marasmus group. The caregivers in the kwashiorkor households put less importance on hygiene. This result was confirmed through measuring the index on oedematous and non-oedematous children after discharge from hospital. The median for the oedematous group was 9.0 compared to 14.5 in the healthy group (Table 4-8).

Each of the indices was then separately examined to determine whether there was a significant relation to the occurrence of nutritional oedemas. The statistical test used for this analysis was Spearman rank correlation. Significant indices were included in the comprehensive logistic regression model (Chapter 6.2) at the end.

The following indices concerning care had a strong relation to the occurrence of nutritional oedema in the children.

Table 4 – 10: Indices belonging to care and their correlation to the occurrence of nutritional oedema

Indices belonging to care	Spearman correlation coefficient (significance level)
Knowledge index	-.266 (**)
Household organisation index	-.482 (**)
Behaviour index of caregivers	-.436 (**)
Hygiene index	-.422 (**)
Problems perceiving in the household index	-.269 (**)
Health prevention index	-.149 n.s.

**P<0.01, n.s.: not significant

Clearly, nearly all different indices concerning childcare had an important impact on the occurrence of nutritional oedema. The smaller the scores of the different indices the higher the occurrence of nutritional oedema (negative correlation). Only the Health prevention index seemed to have a weak significant influence on the occurrence of oedema.

4.7.3.3 Care and the occurrence of nutritional oedema

After all singular indices mentioned above were calculated, a final care index was constructed through adding up the scores for the different indices. The maximum possible score for the care index was 34.5 and the minimum score was –11.5. The mean and standard deviation were 16.0±12.5 respectively. Terciles were created to form 3 categories of caring behaviour: poor, average and good. Terciles of caring behaviour were finally analysed together with different variables, like the occurrence of nutritional oedema etc.

Results of bivariate analyses show a strong association between the care index and the occurrence of kwashiorkor according to the former clinical classification (Figure 4-21). Differences concerning the care given to the children were highly significant between the investigated groups (p=0.000). Fewer children from the kwashiorkor group received good care from their caregivers (5%). The difference in the kwashiorkor group concerning the quality of care received from their caregiver was highly significant (p=0.000). The caring behaviour in the healthy group was varying in the opposite direction. Significantly more children in the control group received good care (90%). The differences in this group were also highly significant (p=0.000). It seems that kwashiorkor can/could be prevented with good care only. In the marasmus group about 20% of the children received good care, meanwhile nearly 80% got only medium or bad care.

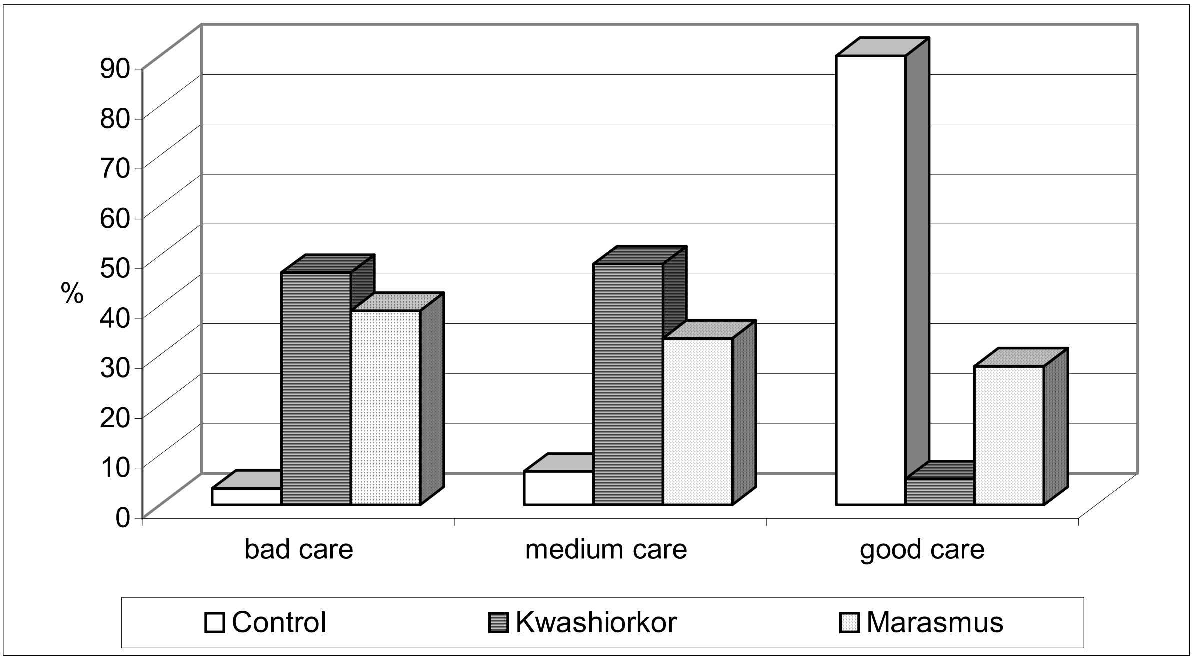

Figure 4 – 21: The association between care (terciles) and ex-PEM

The same effect could be observed when the sample was classified in two groups of oedematous and non-oedematous index children after discharge from hospital. There was a strong negative relationship between care and the occurrence of nutritional oedema (r=-.42; p= 0.000).

In the oedematous group there was no child at all with a caregiver who provided good care whereas in the non-oedematous group about 45% of children had caregivers who scored in the highest tercile of care (Figure 4-22). In both groups the difference in percentage of children getting good, medium or bad care were highly significant different (non-oedematous group p= 0.0076 and oedematous group p=0.003). The data highlight the fact that only the provision of good care seems to protect the child from becoming oedematous.

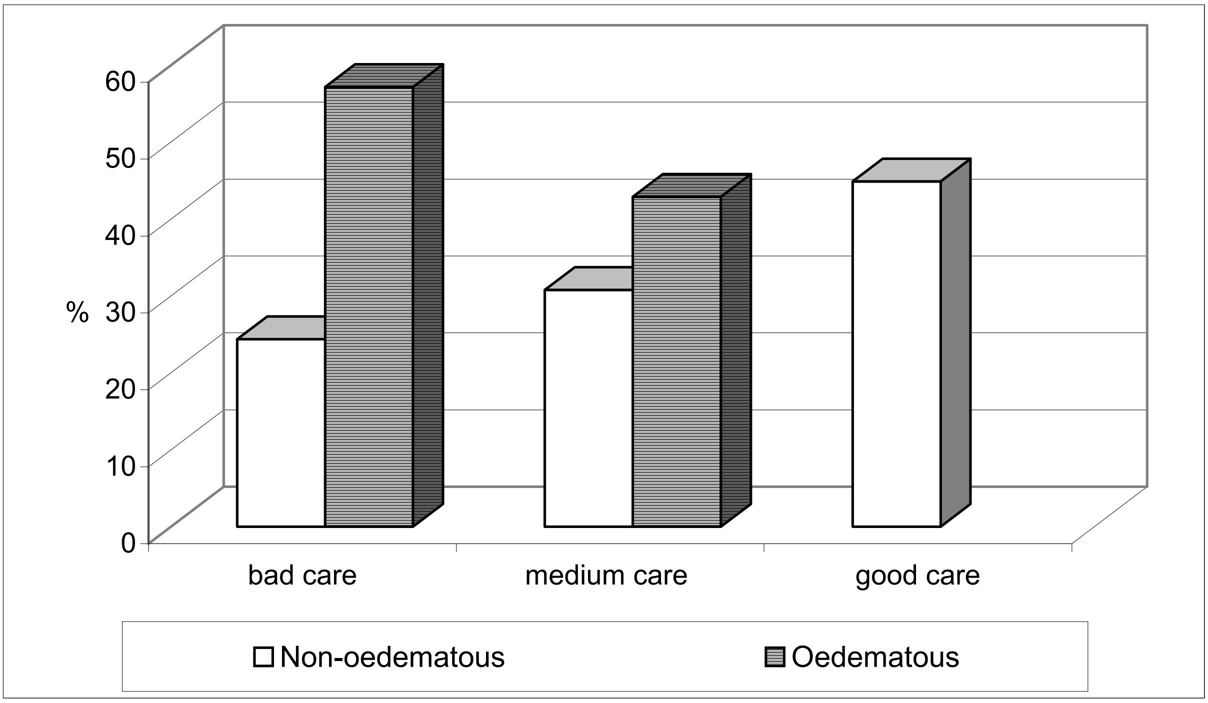

Figure 4 – 22: The association between care (terciles) and the occurrence of nutritional oedema

Behaviour of index children

A child's behaviour was found to be a key element in the quality of care received (IFPRI 1997). For example, a passive child will elicit less response from the caregiver than a demanding one. Caregivers may expend less effort to feed a child who refuses food or is difficult to feed. A positive relationship between caregiver and child leads to an increased intake of food by the child.

In addition to the activity profile where the activities of the index children were registered during 24 hours, the general behaviour of the index children was observed during the 24 hour stay in the family's houses. The behaviour was classified and scores were allocated as mentioned in Table 4-11.

Table 4 – 11: Variables for index: behaviour of child

Variables included in the index of child's behaviour	Scores allocated to different variables	Observed in non-oedematous children (%)	Observed in oedematous children (%)
Active child	Yes: 1 No: 0	Yes: 75	Yes: 22 *
Often crying	Yes: -1 No: 0	Yes: 7	Yes: 19
Happy child	Yes: 1 No: 0	Yes: 67	Yes: 19 *
Sad child	Yes: -1 No: 0	Yes: 12	Yes: 46 *
Mostly sitting child	Yes: -1 No: 0	Yes: 23	Yes: 68 *
Contact to other children	Yes: 1 Sometimes: 0 No: -1	Yes: 80	Yes: 32 *
Child eats additional food outside the house	Yes: 1 No: 0	Yes: 39	Yes: 27 *

* Significance level p<0.05 between the groups

Table 4 – 12: Mean, SD, median, minimum, maximum of index: behaviour of child

Groups		Index: behaviour of child
Non-oedematous	Mean	2.1
	SD	2.3
	Median	3.0
	Minimum	-4.0
	Maximum	4.0
Oedematous	Mean	-0.7
	SD	2.2
	Median	-1.0
	Minimum	-3.0
	Maximum	4.0

The behaviour index as a sum of all variables (p=0.000) as well as most of the individual variables of the behaviour index (all p<0.05) were significantly different between oedematous and non-oedematous children (Table 4-11). This result is underlined when the behaviour index of the post-kwashiorkor and post-marasmic children was compared. The mean of the behaviour index for the post-kwashiorkor children was 0.3, the median 0.0, whereas the mean of the post-marasmic children was 0.8, the median: 1.5. Kwashiorkor children are not happy and are mostly apathetic (LATHAM in BROWN 1990). In this study this behaviour could also be observed, thus confirming previous findings. Moreover, it was observed that most of the children who developed nutritional oedema did not have any contact with other children, neither to siblings nor to neighbour children. This validates the result from the aforementioned activity profile. In many cases the children were totally neglected, either because one of the parents was ill, the caregiver gave more care to a breast-feeding child or the caregiver was someone other than the mother who did not like to take care of the index child. Another consequence of the children's inactivity was that they did not go to neighbouring houses to obtain additional food like other children were doing.

5 IMMEDIATE CAUSES OF MALNUTRITION, ESPECIALLY OF KWASHIORKOR

In the following chapters the immediate causes of malnutrition, the occurrence of diseases and the nutritional background, will be described.

5.1 Illness background

Among the factors that may increase free radicals are illnesses, especially infections. The toxic effects of free radicals could be responsible for cell damage leading to the alterations seen in kwashiorkor.

Regarding hypotheses A 1 (see p.2) it has never been shown that children who develop kwashiorkor **have been exposed to illnesses more often** than children who develop marasmus, although **the pattern of infections** may be different. Measles is often mentioned as precipitating kwashiorkor, particularly in Africa, whereas diarrhoeal disease was reported to be more prominent in marasmus. It has not become clear yet whether this difference might have any relevance for free radical production.

5.1.1 Methods and hypothesis

To prove hypotheses A 1 a questionnaire for illness occurrence was involved in the study. Every 4 months all diseases of the index children (former patients and control children) as well as of all other household members living in the household were registered. In the last survey period information was collected for the occurence of diseases during the 14 days prior to the interview. It has to be born in mind that a bias cannot be totally be avoided, since the person to be interviewed had to remind all the illnesses. All illnesses were counted without making a difference if one illness is more serious than the other.
Only those children from whom the illnesses were registered throughout all investigated seasons in the study period were included in analysis.
In this context the following aspects were to be analysed:
⇒ Was there a **special pattern of diseases** for oedematous children?

⇒ Was there a **seasonal difference** in the occurrence of diseases?

⇒ Were oedematous children **more often exposed to diseases**?

⇒ Were **other household members more often exposed to diseases**?

For that reason the period prevalence of diseases during the 14 days prior to the last interview are shown as well as the occurence of diseases in the **pre-harvest season** - from January until June, and **post-harvest season** - from July to December and finally for both seasons together. According to a seasonal mapping (PRA: Participatory Rural Appraisal) method used with some patient's fathers, the seasons for diseases were separated in pre-and post- harvest season. The pre-harvest season was the worst time of the year for the farmers, since the work load was high and food availability low. In that time people suffered more often from diseases.

5.1.2 Results

After describing the period prevalence of diseases during the 14 days prior to the last interview (Chapter 5.1.2.1), Chapter 5.1.2.2 shows the seasonal influences on the occurende of diseases for the children. Chapter 5.1.2.3 then demonstrates if children from the illness groups had a different illness background than children from the control group and if illnesses are risk factors for the occurrence of nutritional oedema. Moreover this Chapter examines possible differences between the investigated groups regarding the frequency of illnesses. Chapter 5.1.2.4 finally reports about the occurence of illnesses of the other households members.

5.1.2.1 Period prevalence of diseases in the 14 days previous to the last home visit

The period prevalence (sickness during the last two weeks) of diseases in the two weeks prior to the interview at the last visit is presented in Table 5-1.

The figures for diarrhoeal diseases were relatively high for those children who suffered from nutritional oedema during the study period. The differences between the two groups were highly significant. Out of the oedematous group (n=28) about 8 children had nutritional oedema in the 14 days previous to the interview. It seems that diarrhoea, abdominal cramps and loss of appetite are linked with nutritional oedema. All 8 children who had oedema during these two weeks also had diarrhoea. Six of them had abdominal cramps and 4 had a loss of appetite. According to the mother's response one of the oedematous children lost weight. About 85% of the non-oedematous children had no disease during these two weeks compared to only 57% of the oedematous group. Excluding the above mentioned symptoms of nutritional oedema (abdominal cramps, loss of weight, loss of appetite, vomiting) only 15% of the non-oedematous children had a disease during this time period, but 43% of the oedematous children had one disease. In most cases this was diarrhoea. No other disease appeared to occur at the same time as nutritional oedema. Thus, the time period of 2 weeks seems too small for making statements of precipitating diseases in the background of nutritional oedema. More information is provided by Chapter 5.1.2.2, in which all diseases were registered every 4 months of the study year.

Table 5 – 1: Period prevalence of diseases in two weeks previous to the interview at the last home visit (in %), non-oedematous and oedematous children

Diseases	Non-oedematous children n=78	Oedematous children n=28	Significance level (Fisher's exact test) p=
Diarrhoea	6.4	42.9	0.000
ARI	1.3	0	n.s
Fever	1.3	0	n.s
Nutritional oedema	0	28.6	0.000
Loss of appetite	6.4	28.6	0.005
Loss of weight	1.3	3.6	n.s
Abdominal cramps	2.6	32.1	0.000
Vomiting	0	10.7	0.017
Malaria	3.8	3.6	n.s
Number of diseases: (Mean ± SD)	0.3 ± 0.6	1.5 ± 1.8	0.000

n.s : not significant

5.1.2.2 Seasonal influences on the occurrence of diseases

In the following chapter the seasonal influence on the occurrence of special diseases will be revealed. For this reason, all diseases appearing during the study period were registered and a comparison between the seasons for each disease was done. N-par tests from Mac Nemar were applied for statistical prove.

Seasonal influence on occurrence of diseases - ex- PEM patients and control children

The frequency of every disease mentioned in the two seasons was analysed separately for each group investigated.

There was a seasonal influence on diseases of the former kwashiorkor patients. In the **pre-harvest** season **compared to the post-harvest** season more children once admitted with kwashiorkor in Yirga Alem Hospital became oedematous , p=0.0309; suffered from diarrhoea (p=0.0009), loss of appetite (p=0.0026), abdominal cramps (p=0.002) and vomiting (p=0.0625). There was no seasonal disease pattern for former marasmic patients and for the control children.

Seasonal influence on occurrence of diseases - oedematous children and non oedematous children

The occurrence of diseases of the oedematous children (n=28) and the non-oedematous children (n=78) were compared between the two seasons.

The oedematous children suffered from diarrhoea (p=0.065), oedema (p=0.041), abdominal cramps (p=0.012) more often in the **pre-harvest season** than in the post-harvest season. There was no statistical significance between the occurrence of other diseases during the pre- and post-harvest seasons.

The non-oedematous children got the following diseases statistically significantly more often in the pre-harvest season than in the post-harvest season: diarrhoea (p=0.031), loss of appetite (p=0.008), loss of weight (p=0.031) and malaria (p=0.039).

5.1.2.3 Pattern of illnesses

All diseases were compared separately according to the investigated groups to demonstrate if children from the illness groups had a different illness background than the children from the control group.

Ex-PEM patients and control children

Throughout the **pre-harvest** season the frequency of disease occurrences in the different investigated groups, ex- kwashiorkor, ex- marasmic patients and control children were significantly different: diarrhoea (control: 23%, kwashiorkor:48%, marasmus: 28%; p=0.046) , loss of appetite (control: 7%, kwashiorkor:40%, marasmus: 22%; p=0.004), oedema (control: 3%, kwashiorkor: 35%, marasmus: 6%; p=0.001) and abdominal cramps (control: 0%, kwashiorkor: 28%, marasmus: 11%; p=0.004). As mentioned by Mata (1979) the average occurrence of diarrhoeal disease was approximately eight episodes /child per year during the first 3 years of life.

In the **post-harvest** season there were differences in the frequency of occurrences of some diseases, too: loss of appetite (control: 0%, kwashiorkor: 16%, marasmus: 17%; p=0.069), abdominal cramps (control: 0%, kwashiorkor:5%, marasmus: 17%; p=0.052) and oedema (control: 0%, kwashiorkor: 17%, marasmus: 11%; p=0.054).

Comparison of control children and former kwashiorkor separately

In this chapter the Fishers exact test with Shaffer correction was executed. The Shaffer correction was used because the differences of 3 groups was tested by 3 pair wise comparisons. So even if the significance in the single test was less than p=0.001 (***) the result can only be guaranteed to be highly significant (**) .

Pre-harvest season:

Former kwashiorkor children, compared to control children, had more often in this season: oedema (p=0.001**), loss of appetite (p=0.001**) and worms expelled (p=0.001**). In the post-harvest season only oedema (p=0.014) occurred significantly more often in kwashiorkor children. In Zaire, the relationship of childhood protein-energy malnutrition and parasite infections was studied. *Ascaris lumbricoides* was the most prevalent nematode infection in every age group of all observed children (normal, stunting, wasting, kwashiorkor), followed by *Trichuris trichuria* and hookworm. Virtually all children diagnosed with kwashiorkor had diarrhoea, but the prevalence of *A. lumbricoides* was very low, whereas the risk for *T. trichuria* was elevated among those children with kwashiorkor (TSHIKUKA *et al.* 1997)

According to Fishers exact test with Shaffer correction there was no significant difference between the control and the marasmus group. Up to now it is not clear if there is a different pattern of disease in marasmic children compared to kwashiorkor children. In this sample there was only a statistical significance for oedema with kwashiorkor children getting nutritional oedema more often after discharge (p=0.017) in the pre-harvest season. Moreover, kwashiorkor children were more often exposed to diarrhoea (48% and 28% respectively), loss of appetite (40% and 22% respectively), abdominal cramps (28% and 11% respectively), vomiting (10% and 0% respectively) and fever (12% and 6% respectively), but the differences were not significant. This might be explained by the small sample size of marasmic children. On the other hand more marasmic children compared to kwashiorkor children suffered from cough (22% and 12 % respectively), and loss of weight (22% and 7% respectively).

Since the area is much affected with Anopheles flies transmitting malaria, about 16% of the children from all groups contracted this disease in the pre-harvest season. In the post-harvest season there were about 7% of children in each group suffering from malaria.

Oedematous and non-oedematous children

The same procedure was repeated for the classification of the children in oedematous and non-oedematous groups (statistical test: Fishers exact test).

Pre-harvest season:

During this study period more children who became oedematous than those who did not had diarrhoea - 68% and 27% respectively -(p=0.000), loss of appetite -46% and 21% respectively (p=0.01), abdominal cramps - 43% and 8% respectively- (p=0.000), vomiting - 18% and 3% respectively- (p=0.013) and oedemas 79% and 0% respectively (p=0.000). Also other diseases such as cough, chronic cough, fever and malaria were reported more frequently by the caregivers of the oedematous children, but not significantly. Another study in Ethiopia which analysed the clinical pattern of malnourished children reported that 63% of the studied malnourished children had pneumonia, 26% had tuberculosis, 19% of children presented with diarrhoea, 37% of them had clinical and radiological evidence of rickets and 17% had clinical evidence of vitamin A deficiency (SHIMELES and LULSEGED 1994). According to discussions with index children, observations and measurements, the index children's diets were very unbalanced. Children complained of always having the same food to eat. From other studies (JACKSON 1990) it is known that one of the consequences of specific nutrient deficiencies is to provoke an inefficient utilisation of dietary energy, combined with a later, secondary effect upon appetite depression. A return of appetite will not take place until the infections promoting the deficiencies as well as the deficiencies themselves are corrected.

Post-harvest season:

More oedematous children compared to the non-oedematous children had diarrhoea in the post-harvest season - 43% and 12 % respectively- (p=0.001), loss of appetite - 29% and 5% respectively -(p=0.002), loss of weight - 11% and 0% respectively- (p=0.017) and oedemas -43% and 0% respectively- (p=0.000).

Illnesses as risk factors for occurrence of nutritional oedema

To find out which disease might be a risk factor for the occurrence of nutritional oedema Odds Ratios (OR) were calculated. Odds Ratios express the magnification of the risk to become oedematous after having a specific disease. Odds Ratios are significantly different from 1, if 1 is not included in the corresponding confidence interval (CI): in the pre-harvest season diarrhoea - OR=5.7, 95% CI=(2.243-14.636), abdominal cramps - OR=9.0, 95% CI=(2.937-27.576), vomiting - OR=8.3, 95% CI=(1.502-45.44) and loss of appetite - OR=3.4, 95% CI=(1.333-8.460) were risk factors for the occurrence of nutritional oedema. In the post-harvest season the following diseases posed a higher risk for becoming oedematous: diarrhoea OR=5.8, 95% CI=(2.071-15.964), and loss of appetite OR=7.4, 95% CI=(2.021-27.096). As others have noted explicitly (GORDON *et al.* 1964, JELLIFFE 1966b, WRAY 1969), there is an association between the prevalence of diarrhoeal disease in pre-school children and their nutritional status.

Summary: In the pre-harvest season, when food availability was lower, more children became oedematous with the typical complications appearing together or before the oedema. According to discussions with caregivers of oedematous children, in most cases the children lost their appetite, mostly because of their unbalanced diet, got diarrhoea, abdominal cramps and often vomitted before the oedemas were visible. In many cases diarrhoea stopped as soon as the oedemas were seen. These results were confirmed by the first classification conducted at admission, but to an even greater extent by the classification during the time of the study. The above mentioned symptoms appear significantly more often in oedematous children.

According to discussions, the oedema disappears step by step, if caregivers increase the food diversity. Especially buttermilk as food for the children seems to make the oedema disappear. Other diseases, which are often discussed in the background of kwashiorkor like measles or malaria were not observed more often in kwashiorkor children compared to marasmic and control children or between the oedematous and non-oedematous children in this study.

Frequency of disease occurrence

The following results show possible differences between the investigated groups regarding the frequency of illnesses, no matter which kind of illness it was, during the study period. The investigation was done for index children on the one hand and household members of the index children on the other. As performed in other investigations of this study, an analysis for the classification done at admission as well as for the classification done after discharge from hospital was carried out here. For analysis all illnesses registered were counted. Typical complications, which were confirmed earlier to appear together with oedema i.e. abdominal cramps, loss of appetite and vomiting, were excluded from the analysis. Since children also frequently had diarrhoea without getting oedema all diarrhoea cases were included in the analysis of illness frequency.

Illness frequency in ex-PEM patients and control children

Tables 5-2 to 5-4 point out that those index children admitted to hospital once with kwashiorkor or marasmus suffered more often from any kind of disease than the control children after discharge, over the whole study period, independent of season. The mean of the occurrence of disease throughout the year for the controls was: 1.1 ± SD : 1.1; for the kwashiorkor: 2.1 ± SD 1.7 and the marasmic children: 2.1 ± SD 1.4.

Table 5 – 2: Illness frequency in the pre-harvest season, ex-PEM children and controls

Clinical classification	No diseases		At least one disease		Total
	n	(%)	n	(%)	n=106
Control	14	46.7	16	53.3	30
Kwashiorkor	10	17.2	48	82.8	58
Marasmus	2	11.1	16	88.9	18
			p=0.003		

Table 5 – 3: Illness frequency in the post-harvest season, ex-PEM children and controls

Clinical classification	No diseases n	(%)	At least one disease n	(%)	Total n=106
Control	21	70.0	9	30.0	30
Kwashiorkor	27	46.6	31	53.4	58
Marasmus	7	38.9	11	61.1	18
			p=0.054		

Table 5 – 4: Illness frequency throughout the entire study period, ex-PEM children and controls

Clinical classification	No diseases n	(%)	At least one disease n	(%)	Total n=106
Control	11	36.7	19	63.3	30
Kwashiorkor	9	15.5	49	84.5	58
Marasmus	2	11.1	16	88.9	18
			p=0.032		

Illness frequency for oedematous and non-oedematous children

The following investigations clearly show that children suffering from nutritional oedema were significantly more exposed to one or more illnesses throughout a defined study period than control children. The mean for the occurrence of disease for the non-oedematous was 1.6 ± SD1.4, for the oedematous children: 2.5 ± SD 1.8 diseases throughout the year. The risk of becoming oedematous was about 3 to 6 times higher, depending on the season, if the children suffered from one or more illness (see OR and CI!).

Table 5 – 5: Illness frequency of oedematous and non oedematous children in the pre-harvest season

Classification	No diseases n	(%)	At least one disease n	(%)	Total n=106
Non - oedematous children	24	30.8	54	69.2	78
Oedematous children	2	7.1	26	92.9	28

P=0.013 (Chi-square test); OR: 5.778 ; CI (1.268-26.324)

Table 5 – 6: Illness frequency of oedematous and non oedematous children in the post- harvest season

Classification	No diseases n	(%)	At least one disease n	(%)	Total n=106
Non - oedematous children	45	57.7	33	42.3	78
Oedematous children	10	35.7	18	64.3	28

P=0.046 (Chi-square test); OR: 2.455; CI (1.004-6.001)

Table 5 – 7: Illness frequency of oedematous and non oedematous children throughout the entire study period

Classification	No dis-eases n	(%)	At least one disease n	(%)	Total n=106
Non - oedematous children	20	25.6	58	74.4	78
Oedematous children	2	7.1	26	92.9	28

P= 0.038 (Chi-square test); OR: 4.483; CI (0.975-20.607)

5.1.2.4 Illness frequency of household members

The following tables highlight the difference in the occurrence of illnesses for the other household members for former kwashiorkor, marasmic and control children.
Over the two seasons as well as over the entire study period there were important differences concerning the frequency of illnesses of the other household members beside the illnesses the index child was exposed to. Over the study period about three quarter of the control households reported that the other members of the households had no diseases, whereas in the illness groups it was reported in half, or more than half of the households that the other household members suffered from at least one other disease (Table 5-10). The occurrence of diseases in the post-harvest season was significantly different between the investigated groups (p=0.0135), as it was over the entire study period (p=0.00087). In the pre-harvest season the differences were not so strong (p=0.099).

Table 5 – 8: Illness frequency of other household members in the pre-harvest season, households with ex-PEM children and controls

Clinical classification	No diseases		At least one disease		Total
	n	(%)	n	(%)	n=106
Control	24	80.0	6	20.0	30
Kwashiorkor	34	58.6	24	41.4	58
Marasmus	10	55.6	8	44.4	18

Table 5 – 9: Illness frequency of other household members in the post-harvest season, households with ex-PEM children and controls

Clinical classification	No diseases		At least one disease		Total
	n	(%)	n	(%)	n=106
Control	25	83.3	5	16.7	30
Kwashiorkor	30	51.7	28	48.3	58
Marasmus	12	66.7	6	33.3	18
			p=0.0135		

Table 5 – 10: Illness frequency of other household members throughout the entire study period, households with ex-PEM children and controls

Clinical classification	No diseases		At least one disease		Total
	n	(%)	n	(%)	n=106
Control	23	76.7	7	23.3	30
Kwashiorkor	20	34.5	38	65.5	58
Marasmus	9	50.0	9	50.0	18
			p=0.00087		

The following data show the occurrence of diseases in all other household members of those households where a child with oedema lived during the study period compared to those households without an oedematous child. In this analysis not only the index children were taken into account but also the siblings of the index children (in addition to the 28 index children who became oedematous, 9 siblings who became oedematous during the study period were added). This sample better corresponds to the disease frequency in the whole household.

Tables 5-11 and 5-12 separately show results from the pre-harvest and post-harvest season and Table 5-13 finally for both together.

In both seasons as well as over the entire study period the results clearly show that in households where a child got nutritional oedema after discharge from hospital, the other household members were exposed significantly more often to any disease than in households where the children did not get oedema (pre-harvest season:p=0.00421; post-harvest season: p=0.00696; entire study period:p=0.00004).

These results indicate that in households where a household member, in most cases the head of household or the caregiver, fell ill, the care seems to be concentrated on that person. The risk for the index child to be neglected during this time increases. Care seems to play a significant role in the occurrence of nutritional oedema, which will be confirmed in the final analysis (Chapter 6.2).

Table 5 – 11: Illness frequency of other household members in the pre-harvest season, households with oedematous and non-oedematous children

Classification	No diseases n	(%)	At least one disease n	(%)	Total n=106
Non-oedematous children	51	73.9	18	26.1	69
Oedematous children	17	45.9	20	54.1	37
			p=0.00421		

Table 5 –12: Illness frequency of other household members in the post-harvest season, households with oedematous and non-oedematous children

Classification	No diseases n	(%)	At least one disease n	(%)	Total n=106
Non-oedematous children	50	72.5	19	27.5	69
Oedematous children	17	45.9	20	54.1	37
			p=0.00696		

Table 5 – 13: Illness frequency of other household members throughout the entire study period, households with oedematous and non-oedematous children

Classification	No diseases n	(%)	At least one disease n	(%)	Total n=106
Non-oedematous children	44	63.8	25	36.2	69
Oedematous children	8	21.6	29	78.4	37
			p=0.00004		

Concerning post-marasmic and post-kwashiorkor children the figures (Figure 5-1) clearly show that more than 90% of the post-kwashiorkor children compared to about 77% of the post-marasmic children suffered from at least one disease over the study year. Especially in the time period between July and December more children suffered from at least one disease, but more of the kwashiorkor children suffered in both seasons from at least one disease (Figure 5–2 and Figure 5–3).

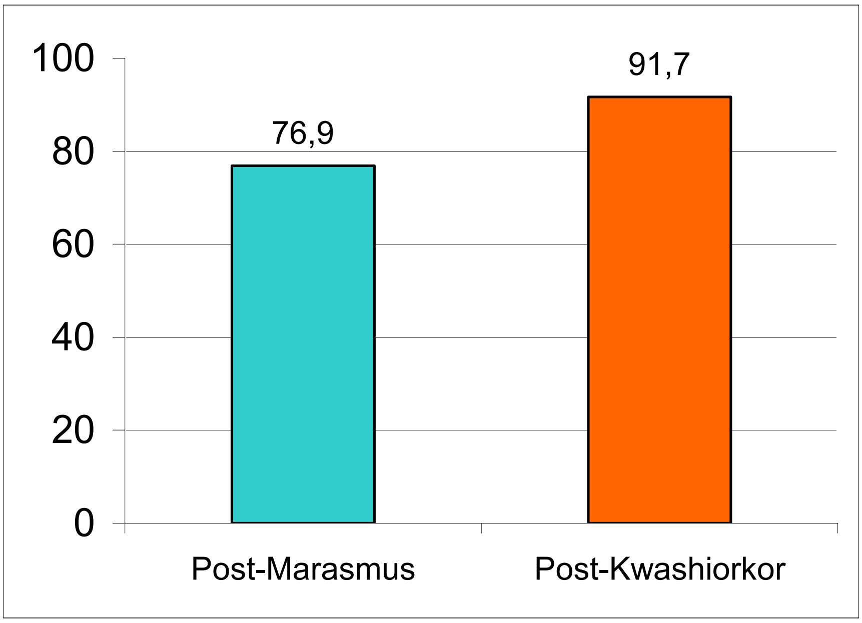

Figure 5 – 1: **Illness frequency (at least one disease) for post-marasmic and post-kwashiorkor children throughout the entire study year**

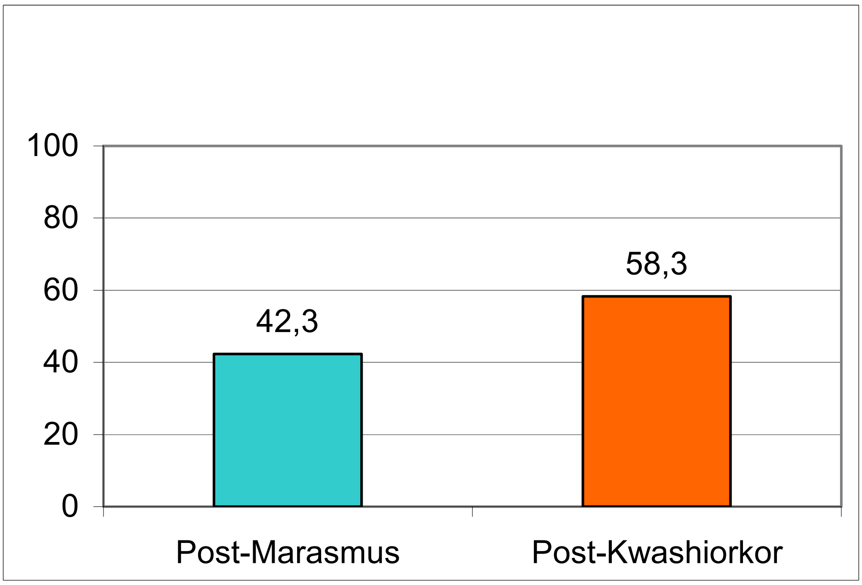

Figure 5 – 2: **Illness frequency (at least one disease) for post-marasmic and post-kwashiorkor children from January to June**

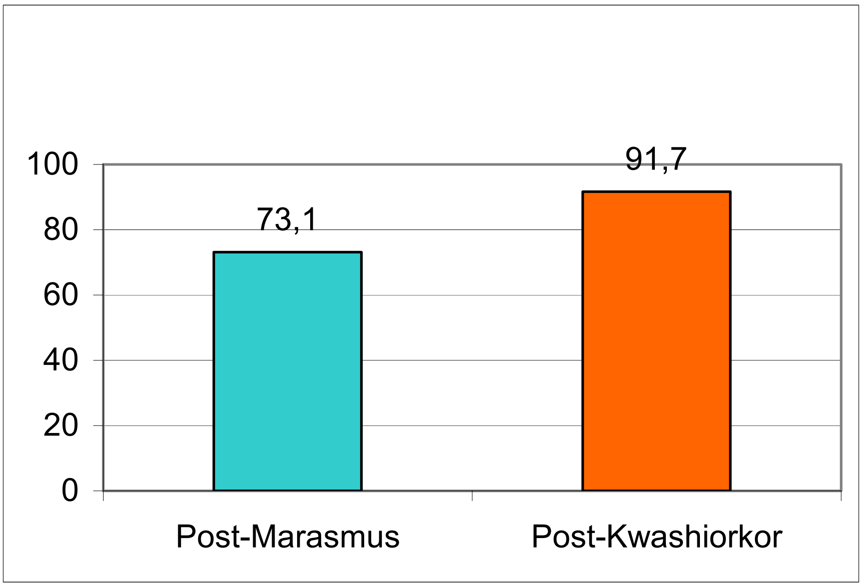

Figure 5 – 3: Illness frequency (at least one disease) for post-marasmic and post-kwashiorkor children from July to December

Figure 5–4 clearly demonstrates that other household members of the post-kwashiorkor children were also ill more often than household members of the post-marasmic children. This result confirms what was observed when the classification was done with the oedematous and non-oedematous households.

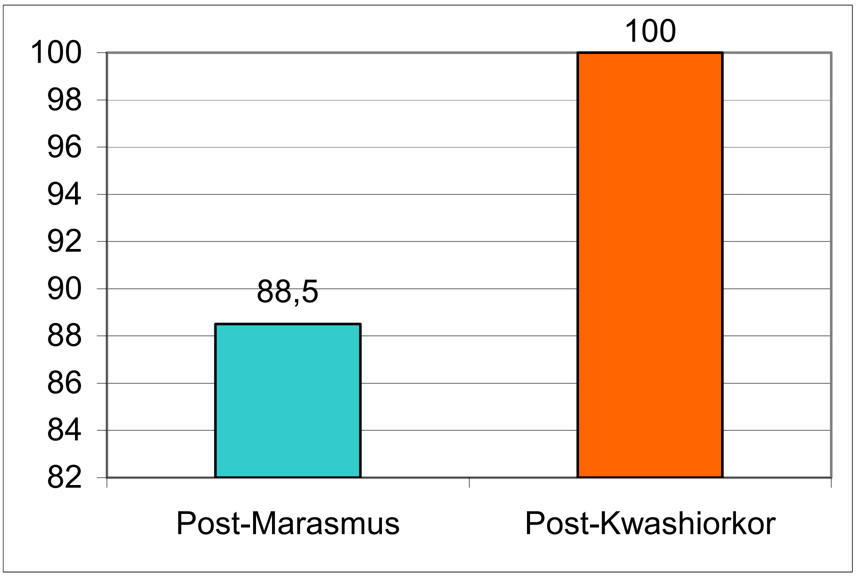

Figure 5 – 4: Illness frequency (at least one disease) for other household members of post-marasmic and post-kwashiorkor children throughout the entire study period

Summary: Oedematous children were not exposed to a special pattern of infection, but suffered significantly more often than non-oedematous children from diarrhoea. The typical symptoms occurring together with the oedema or mostly before the oedema were diarrhoea, abdominal cramps, loss of appetite and often vomiting. These symptoms were found significantly more often in the oedematous patients. In the pre-harvest season the danger of getting oedema was higher than in the post-harvest season. In the pre-harvest season illnesses were in general more frequent. Oedematous children were significantly more often exposed to diseases, but not to any one in particular. The risk of becoming oedematous was higher if the number of diseases the child was exposed to increased. The results also show that in households where a child became oedematous the other household members were exposed more often to any kind of illness. The differences were also seen when only post-kwashiorkor children were compared with post-marasmic children. More post-kwashiorkor children suffered from at least one disease during the study period and also their other household members were ill more often than those of the post-marasmic children. Care seems to play an important role in these households.

The frequency of infections in the studied index children increases the risk that nutritional deficits are not appropriately corrected. The next chapter will therefore deal with the nutritional intake of index children to determine whether the children also had an unbalanced diet in addition to frequent illnesses.

5.2 Nutritional background of the index children

The following Chapters give an overview of the nutritional background of the index children. Since breastfeeding and weaning practices might have an influence on the occurence of PEM, information was therefore gathered on the duration of breastfeeding, the age at which food was introduced, and the kinds of foods and drinks given. The consumption pattern of the children was assessed through food frequencies. For the precise evaluation of the individual's food and nutrient intake exact food weighing was performed.

5.2.1 Breastfeeding and weaning practices and their relation to PEM

To obtain information on breastfeeding the mothers who had stopped breastfeeding the child were asked to state the age at which they had done so.
The average duration for breastfeeding was 26.7 months (SD : ±7.9, median: 25.5) in the control group, 23.2 (SD : ±13.2, median: 24.0) in the ex-kwashiorkor group and 19.9 (SD : ±11., median: 12) in the ex-marasmus group. The children who developed nutritional oedema after discharge from hospital were on average breastfed until the age of 24 months, the same was shown for the non-oedematous group. A quite higher percentage of mothers from the ex-PEM groups had stopped breastfeeding at the child's age of up to 18 months (Table 5-14). None of the mothers from the control group had stopped breastfeeding their child before the 8th month. Especially mothers from the ex-marasmic children stopped breastfeeding their child earlier. Reasons for stopping breastfeeding are illustrated in Table 5-15. Most of the mothers from the control and the kwashiorkor group stated a new pregnancy as the reason for stopping breastfeeding the child. Especially mothers from marasmic children mentioned other reasons such as the sickness of the mother, the child not wanting the milk or separation of the parents.

Table 5 – 14: Duration of breast feeding (in months) by ex-PEM and control children /non- oedematous and oedematous children

Months	Control	Kwashior-kor	Maras-mus	Non-oedematous	Oedema-tous
0-7	-	8.2	9.1	9.4	-
8-18	15.0	32.7	45.5	28.3	33.3
19-23	5.0	4.1	3.8	5.7	-
>=24	80.0	55.1	45.5	56.6	66.7

Table 5 – 15: Reasons for stopping breastfeeding in the groups (frequencies of caregivers answer in %)

Reasons	Control n=20	Kwashiorkor n=49	Marasmus n=11
New pregnancy	70.0	75.5	54.5
Mother's sickness	5.0	4.1	9.1
Child refuses the milk	25.0	6.1	18.2
Separation of parents	-	4.1	18.2
Others	-	10.2	-

The weaning pattern is described not only by the period of breastfeeding but also by the time of introducing other food (apart from breast milk, including fluids) and its quality. Therefore the age at which the child receives additional food as well as the kinds of food were investigated.

Table 5-16 reveals the common habit of Sidama women to introduce other fluids than breast milk shortly after birth. Especially the mothers from the ex-PEM children gave their child water and herbal tea for drinking shortly after birth.

Table 5 – 16: Drinks other than breast milk introduced to the diet shortly after birth in the investigated groups (frequencies of caregivers answer in %)

Drinks	Control n=29	Kwashior-kor n=56	Maras-mus n=18	Significance level p=
Water	13.8	30.4	50.0	0.028
Herbal tea	55.2	80.0	83.3	0.029

Figure 5–5 portrays the weaning profile of the index children with the accumulated frequencies of caregivers introducing other foods apart from breast milk. As shown in

this Figure the majority of the control mothers started to give additional foods at the age of 6 months. Nearly 25% of the mothers from the PEM groups had started before the 5th month. Only about 14% of mothers from the control children introduced foods other than breast milk before the 5th month. Some mothers (17%) from the kwashiorkor group introduced additional food at the age of 8 months or even later. Also about 10% of the children from the control and the marasmus group had received additional food at this age. Within 8 months all children from the marasmus group were weaned.
The average age at which weaning food other than fluids was introduced was about 6th months in all investigated groups. Having in mind that the most mothers were giving fluids like water and tea after birth, the general recommendations (UNICEF/WHO/UNESCO 1989) to start at 6 month with other food is not fulfilled in the sample.

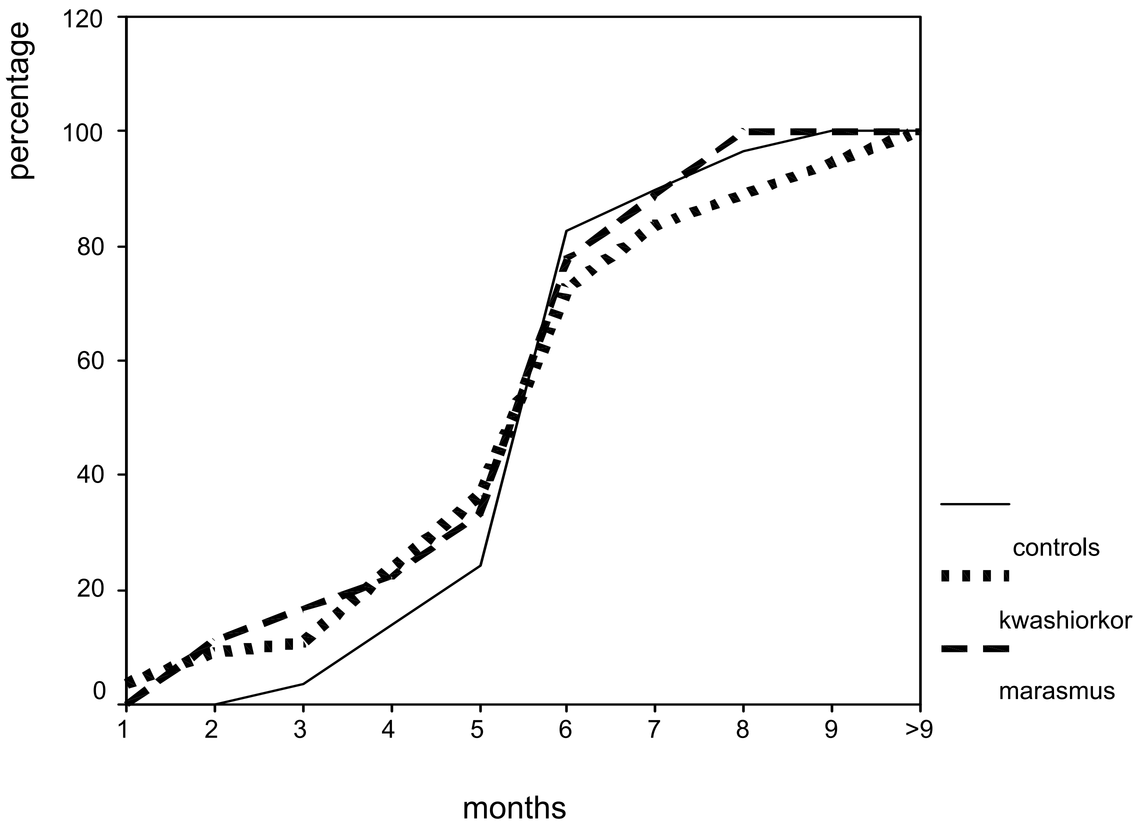

Figure 5 – 5: Profile of weaning process

The weaning pattern (Figure 5–6) of control children compared to the PEM children shows some significant differences. 50% or more of the ex-PEM children received maize porridge as an additional food, compared to only 30% of the control children. Other porridges made from wheat, barley, teff or a mixture of cereals were given comparably often to all children. As to the porridge, it has to be borne in mind that the consistency can vary from thin to thick. More mothers from the control group used nutritional fat in the diet of the young children. For them it was more important to add eggs, milk, mostly in form of butter milk, and fruits to the diet of the child. The differences between the groups were significant (p=0.006 , 0.007, and p=0.000 for eggs, milk and fruits respectively). The lowest numbers of mothers giving milk to the child were the mothers from the ex-kwashiorkor children. As mentioned above the control households had more milk available, but especially the kwashiorkor households sold quite a high proportion of their milk. Potatoes were given to the child by more than 30% of the mothers from the control group, whereas only 22% of the marasmic children and 14% of the kwashiorkor children received potatoes. A quite higher number of mothers of the ex-PEM children reported to have given *kocho* to their children. Moreover about 6% of the ex-PEM-children receive *injera* and *wot*. So quite a part of the ex-PEM children had already been given adult food at weaning.

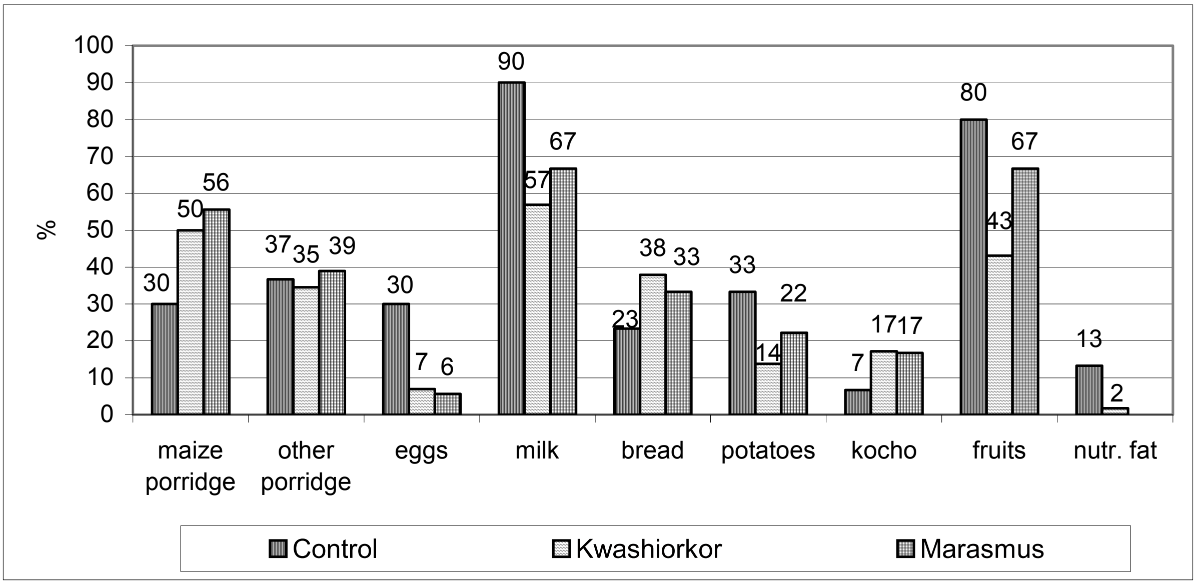

Figure 5 – 6: Types of weaning foods given to the children, ex-PEM children and controls

5.2.2 Food intake

The following hypothesis can be postulated in the causal chain of kwashiorkor:

Children with kwashiorkor, compared to those with marasmus and those without nutritional oedema, have been more exposed to

A 2: factors that compromise defence against free radicals.

It has to be analysed if children with kwashiorkor take **less foods rich in antioxidants**: especially foods rich in sulphur-containing amino acids, zinc, selen, vitamin E, vitamin A and vitamin C. Foods rich in sulphur-containing amino acids as well as zinc are found in the Sidama zone: meet, eggs, milk and milk products. Some pulses like lentils are also quite rich in zinc. Out of the cereals wheat has the highest content of sulphur-containing amino acids, but also teff commonly used for preparing *injera* has a much higher content of those amino acids than *ensete*. High in Vitamin E are plant oils and avocados. Vitamin A is present in milk and eggs as retinyl esters and in plants as carotenoids. In Sidama *gomen,* pumpkin and green pepper are the most important sources of ß-carotenoids.

To asses the food intake of the patients and control children **food frequency** data for the week before the interview was gathered (every 4th month) for the ex-patients as well as for control children living in the direct neighbourhood of the patients. Waterlow (1975) claimed that actual food intakes of individual children, and not simply of the family as a whole have to be made. Moreover, because of the difficulties of measuring intakes of breast milk, studies must be made on children who have been completely weaned. Studies, which fulfil those criteria, show that children who are 1-2 years old have a greater deficit in energy than in protein.

Thus in this study, in addition to food frequency data, **nutrient intake** was assessed through exact food weighing over 24 hours for the index children every 4th month during the home stays of the team members. A distinction was made between oedematous and non-oedematous groups of children to confirm a causal relationship between food intake and occurence of nutritional oedema. In addition, data for the post-kwashiorkor and post-marasmic children is presented. In the latter investigation, it has to be borne in mind that the sample was rather small.

5.2.2.1 Consumption frequency

5.2.2.1.1 Method

To assess the consumption pattern of the observed children the respondents were requested to estimate the frequency of foods consumed during the week before the interview. Considering the impact of different seasons the analysis was performed for three seasons, thus three visits gave information about this subject. The food frequency was assessed with a standardised questionnaire.

For each food assessed the median was calculated, indicating the point on the measuring scale with 50% of the measured values above and 50% below it. Therefore, the median indicates the category on the measuring scale, which is reached by at least 50% of the children for the respective food. In the following tables the median of the most frequently consumed foods in Sidama, as tested in a pre-test, is presented. Slight or noticeable differences are indicated by the addition of plus and minus signs.

Data is presented according to the clinical classification as categorised at the hospital (ex-PEM children and controls), according to the classification in oedematous and non-oedematous children after discharge from hospital. In addition, data for the small sample of post-kwashiorkor and post-marasmic children is presented. The data from this small sample will clarify differences concerning the food intake between kwashiorkor and marasmic children.

5.2.2.1.2 Results

Ex-PEM children and controls

A possible impact of different seasons on food pattern is shown in Table 5-17..
Ensete, meet, egg, butter and buttermilk are available throughout the year at the market. The maize harvest is in June and July, after this time dried maize is sold at the market. In the pre-coffee season guavas are harvested.
For all people the time between April and July is the most difficult season in the year. From August to November it is the main coffee harvest time. For most of the farmers in this area coffee is the main source of income. At this time other foods are also ready for harvest, like pumpkin, *teff* etc. During the time from December to March pulses, avocados and potatoes are harvested. Most people still have dried maize in their house. The consumption of pulses strongly depends on the season, but usually pulses, with exception of red kidney, are bought at the market instead of obtaining them from own cultivation.

During the season between **April and July** the ex-PEM children ate a very unbalanced diet. Especially the ex-kwashiorkor children were fed twice a day with *kocho*, which is prepared out of *ensete*. Concerning the ex-marasmic children, the consumption frequency of the main staple foods was very low. The median for the consumption frequency for *ensete* was only “four times a week” and maize was consumed only three times a week. In June and July the first maize was harvested. Thus, maize appears in the diet of all groups about three times a week.
Kocho or maize are mostly served together with *gomen*. Once more, the children from the marasmus group got this vegetable only once a day, the other children ate gomen about twice a day.

Foods rich in protein were under-represented in the diet of the ex-illness groups. The median of the consumption frequency of any pulses was “once a week” compared to the control children who ate pulses about two times a week. Other cereals such as wheat, barley or teff were only available in the diet of the control children. Buttermilk, another important source of protein, was consumed only once a week by children of both illness groups, whereas the children from the control group drank buttermilk about twice a week.

Foods rich in vitamins and micro-nutrients were strongly missing in the diet of the ex-patients, especially in the diet of the ex-marasmic children. The ex-marasmic children ate foods rich in Vitamin C such as *gomen* and guava less often.
The median for the consumption frequency of all fruits in the control group was generally about one time more per week than in the illness groups. With the exception of *gomen*, which was most frequently eaten by the kwashiorkor group and the control group, there were other vegetables like onions and green pepper lacking especially in the ex-illness groups. Onions are rich in sulphur, which is necessary for anti-oxidative reactions. Green pepper has a high content of vitamin C and β-carotene.

The data show that foods rich in fat were grossly lacking in the diet of the ex-PEM patients. Nearly every day the children from the control group received some oil, whereas the kwashiorkor children were given oil three times a week and the marasmic children only twice. Moreover, avocados were available more often to the control children compared to the children of both of the illness groups. In the case where only the non-breastfed children were compared, the ex-kwashiorkor children consumed the lowest number of avocados. Because of a lack of fat intake the absorption of fat-soluble vitamins can be expected to be strongly diminished for the ex-PEM group.

The foods consumed by the two illness groups were extremely unbalanced compared to the control group in this season. Nevertheless, in all households the food variability was quite low.

In the months between **August and November** more income was available for all households (Chapter 4.3.3), mostly because of the coffee harvest. During this time the consumption of buttermilk increased for the illness groups, whereas the control group drank buttermilk about three times a week throughout the year. Teff was consumed once a week in all groups. Since the Ethiopian New Year celebration was in September, *injera*, which is made out of *teff*, was also eaten once a week in the ex-illness groups.

Between **December and March** foods consumed more often were: red kidney beans, beans, teff, onions, green pepper and avocados compared to the other seasons. Maize was regularly eaten by the ex-marasmic and control children, whereas the ex-kwashiorkor children were highly dependent on *kocho* throughout the year.

Obviously the households from the control group were not so dependent on seasonal influences as the ex-PEM groups. Buttermilk and pulses, as main sources of protein, were regularly consumed throughout the year and also more often compared to the ex-PEM patients. The diet was composed out of diverse foods leading to a more balanced intake.

Table 5 – 17: Seasonal influence on consumption frequency of certain foods, ex-PEM children and control
(M: marasmus; K: kwashiorkor; C: control)
(Figures in brackets portray the sample without the breastfed children if differing to the median of the whole sample)

Season	**April – July**			**Aug. – Nov.**			**Dec.- March**		
Groups	**M** n=18	**K** n=58	**C** n=30	**M** n=18	**K** n=58	**C** n=30	**M** n=18	**K** n=58	**C** n=30
Foods									
Animal proteins	-------	---------	-------	-------	---------	---------	--------	--------	--------
Meet	0	0	0	0	0	0	0	0	0.5 (0)
Egg	0	0	0 (0.5)	0	0	0	0	0	0
Buttermilk	0 (1)	1	2 (3)	2	1.5	2.5	1	1	3
Ensete /cereals	--------	---------	--------	---------	---------	------ ---	---------	---------	---------
Ensete	4	14	10.5	14	14	3	14	14	7
Maize	3	3	3	7	4 (3.5)	3.5 (3)	7	4	3.5 (3)
Teff	0	0	1 (2.5)	1 (0)	1	1 (0.5)	0	1(0.5)	1 (0)
Barley	0	0	0	0	0	0	0	0	0
Wheat	0	0	1	0	0	0	1	0	1 (1.5)
Potatoes	0	0	0	0	0	0	0	0	1.5 (2)
Pulses	--------	---------	---------	---------	---------	---------	---------	---------	---------
Red kidney	0	1	2	0 (2)	1	2	1.5 (2)	2	3 (4)
Beans	0 (1)	0	2	0	0	0	0	1	2 (1.5)
Vegetables	---------	---------	---------	---------	---------	---------	---------	---------	---------
Gomen	7	14	14	14	14	14	14	14	14
Pumpkin	0	0	0	0	0 (0.5)	2.5 (3)	0	0	0
Onion	4	3	5.5	3	3	14(10.5)	5.5 (3)	7	14(10.5)
Green Pepper	0	0	2.5	2 (2.5)	4	7 (5.5)	1 (3)	7	7 (5.5)
Fruits	---------	---------	---------	---------	---------	---------	---------	---------	---------
Avocados	1 (2)	1	2	0	0	0	2.5 (2)	2	3
Bananas	1	1	2	0	1	2	1 (0)	1	2
Guava	1	2	3	0 (1)	1	2.5	0	0	0
Vegetable Oil	2	3	4 (5.5)	2 (1)	2	14 (7)	3.5 (2)	3.5 (4)	7
Butter	0	0	0	0	0	0 (0.5)	0	0	2

Codes: 0= never 1 = once 2 = 2 times a week 3 = 3 times a week 4 = 4 times a week 7= daily once 14= daily more than once

Oedematous and non-oedematous children

To document the prospective impact of the diet on nutritional oedema, the following Table (Table 5-18) present the food pattern of children in different seasons who developed nutritional oedema after discharge from hospital compared to the other children who did not get oedema during the study time. According to discussions and observations the children had a very unbalanced diet before the development of nutritional oedemas, their daily diet mostly consisted only of *kocho*, prepared from the *ensete* plant and from *gomen*, consumed along with *kocho*. The children normally ate their food very late in the evening, so that their appetite was low and therefore they were not able to finish their meal. Mostly they ate the rest of the *kocho* the next day without it being re-heated. An overgrowth of bacteria in this leftover food was possible. A sample of left-over -*kocho* from two households was taken and analysed for *Escherichia coli*, in the microbiological laboratory in the Yirga Alem Hospital. *E. coli* may cause diarrhoea. In both samples *E. coli* were found.

Table 5-18 shows that especially the oedematous children were depending mainly on the *ensete*. They ate *kocho* at least twice a day compared to the non-oedematous children who received this kind of food once a day. There were no seasonal differences since *ensete* is the main staple food in this region. Along with *ensete*, *gomen* is consumed and therefore, throughout the year all children ate this kind of vegetable at least two times a day. As an alternative to *kocho,* maize bread *kita* was served. The maize harvest is normally between June and August. The data show that non-oedematous children consumed maize one time more per week during the harvest time. During the season between December and March mostly dried maize was bought from the market. Children from both groups consumed this kind of maize about 4 times a week. The data highlight the fact that for the healthy children cereals were an important part of the diet beside the main staple food. About once a week during the whole year they ate *teff* out of which *injera* was prepared. Since teff is not planted in this region, this cereal is bought at the market. From December to March the healthy children ate wheat once a week, either in the form of roasted wheat corn or bread. Wheat is - in comparison to the other foods eaten - particularly rich in sulphur-containing amino acids.

Beside cereals, the consumption of pulses helps to make the diet of the healthy children more balanced. Either red kidney beans and/or white beans (in Amharic: *bakela*) were part of the diet of the healthy children throughout the year. In the harvest time from April to July and from December to March the healthy children were given pulses about 4 times a week, whereas the oedematous children ate pulses only once or twice a week. The main dish *kocho* with *gomen* and sometimes with red kidney beans is mostly prepared with oil or butter. Importantly, the healthy children's diet contained more oil. Whereas they got oil 3 to 4 times a week during the entire year, the oedematous children only received oil 2 to 3 times a week. Moreover, the healthy children received butter about once a week in the post-coffee season plus some additional fat from avocados which they consumed 2 to 3 times during the harvest times. The oedematous children only received avocado about once a week between December and March and the median for butter consumption was 0 throughout the year. The contribution of fruits and vegetables beside *gomen* to the diet of oedematous children was tremendously low. Green pepper, which is rich in Vitamin C and ß-carotene, was consumed regularly only during the season from December to March. In the coffee-season the healthy children ate green pepper about once a day, whereas in the diet of the oedematous children this vegetable was included only about 3 times per week. Pumpkin, which is normally harvested in the time between August and November, was only observed in the healthy children's diets.. All children consumed other main fruits, bananas and guavas, with a similar frequency. Onions especially were present more frequently in the healthy children's diets. All children rarely consumed foods originating from animals.

The main source of animal protein in this sample was buttermilk. Buttermilk and butter are usually prepared from cow's milk, thus whole milk is hardly ever consumed. Butter is consumed only in times of celebration or in times of illness. Besideits use as a food item, butter has an important role as a cosmetic for hair and skin. Therefore, the consumption of butter was very low for all children.
The healthy children drank buttermilk about 2 times a week throughout the year with the exception of the pre-harvest time. The oedematous children received buttermilk mostly once a week. Only in the coffee-season did they drink some milk twice a week. In summary, the food frequency data indicate that the diet of the oedematous children was extremely unbalanced.

Table 5 - 18: Seasonal influence on consumption frequency of certain foods, non-oedematous (NO) and oedematous (O) children
(Figures in brackets portrays the sample without the breastfed children in the sample if differing to the median of the whole sample)

Season	**April – July**		**Aug. – Nov.**		**Dec.- March**	
Groups	**NO** n=78	**O** n=28	**NO** n=78	**O** n=28	**NO** n=78	**O** n=28
Foods						
Animal proteins						
Meet	0	0	0	0	0	0
Egg	0	0	0	0	0	0
Butter Milk	1	1	2	2	2	1-
Ensete	7	14+	7	14+	7(14)	14
Cereals						
Maize	3	2 -	4	3 -	4(3.5)	4
Teff	1	0 -	1	0 -	1	0 -
Barley	0	0	0	0	0	0
Wheat	0	0	0	0	1	0 -
Potatoes	0	0	0	0	1	0 -
Pulses						
Red kidney	2	1 -	1	0 -	3	1 --
Peas/beans/ lentils	0/1 (2)/0	0/1/0 (-)	0/0/0	0/0/0	0/1/0	0/0/0 -
Vegetables						
Gomen	7(14)	14	14	14	14	14
Pumpkin	0	0	1	0 -	0	0
Onion	4	2 --	7	2 ---	7	7
Green Pepper	0	0	7	3 --	7	7
Fruits						
Avocados	2	0 --	0	0	3	1--
Bananas	1	1	1	1	2 (1.5)	1-
Guava	2	2	1.5 (1)	2	0	0
Vegetable Oil	3	3	4 (3)	2 --	4	3-
Butter	0	0	0	0	1	0-

Codes: 0= never 1 = once 2 = 2 times a week 3 = 3 times a week 4 = 4 times a week
7= daily 14= daily more than once; -: food was eaten one times less often; +: food was eaten one times more often compared to the other group

Taking into consideration that most of the oedematous children ate *kocho* more than once every day, these results clearly show that the food consumed by those children was mainly composed of carbohydrates. Foods containing antioxidants to some extent were rare in the diet of those children. The diet of the healthy children was much more balanced, composed from a variety of different foods. Cereals, beans, avocados, onions, green pepper and buttermilk were consumed more often by the children without oedema.

Post-kwashiorkor and post-marasmus

Comparing only those children who suffered from marasmus or kwashiorkor after discharge from hospital there were some differences concerning the food frequencies. The marasmic children consumed more often, across all seasons investigated, maize and beans (Table 5-19). Especially in the post-harvest season the marasmic children seemed to have a higher food variety. They consumed more often protein rich foods such as buttermilk and beans. Maize, a food which provides not only carbohydrate but is also an important source of protein, was eaten in the mean daily by the marasmic children, but only twice a week by the kwashiorkor children. Also avocados, which are rich in fat containing unsaturated fatty acids, were more often eaten by the marasmic children. In both groups the main food was *kocho* and *gomen*.

Table 5 – 19: Seasonal influence on consumption frequency of certain foods, post-marasmic (p-M) and post-kwashiorkor (p-K) children after discharge from hospital
(Figures in brackets portrays the sample without the breastfed children in the sample if differing to the median of the whole sample)

Season	**April – July**		**Aug. – Nov.**		**Dec.- March**	
Groups	p-M n=23	p-K n=12	p-M n=23	p-K n=12	p-M n=23	p-K n=12
Foods						
Animal proteins						
Meet	0	0	0	0	0	0
Egg	0	0	0	0	0	0
Buttermilk	1	1	1	1	1	0 -
Ensete	14	14	14	14	14	14
Cereals						
Maize	3	2 -	5.5	3 --	7	2-----
Teff	0	0	0	0	0	0
Barley	0	0	0	0	0	0
Wheat	0	0	0	0	0.5	0 -
Potatoes	0	0	0	0	0	0
Pulses						
Red kidney	0	1 +	1	0 -	2.5	2-
Peas/beans/lentils	0/1/0	0/0-/0	0/0/0	0/0/0	0/1/0	0/0-/0
Vegetables						
Gomen	14	14	14	14	14	14
Pumpkin	0	0	0	0 -	0	0
Onion	3	2 --	3	2 -	7	10.5+++
Green Pepper	1	2+	2	1 -	7	2.5-----
Fruits						
Avocados	1	1	0	0	2.5	1-
Bananas	1	1.5	1	1	0.5	1
Guava (zeitone)	1	2+	1	2	0	0
Vegetable Oil	2	3+	1	2 +	3	3
Butter	0	0	0	0	0	0-

Codes: 0= never 1 = once 2 = 2 times a week 3 = 3 times a week 4 = 4 times a week
7= daily 14= daily more than once;
-: food was eaten one times less often; +: food was eaten one times more often compared to the other group

5.2.2.2 Adequacy of the diet

5.2.2.2.1 Method

In order to obtain information on food intake and the adequacy of the diet, exact food weighing was performed. This method is appropriate for precise evaluation of the individual's food intake. For weighing the food, electronic digital diet weighing scales powered by batteries were used. Foods heavier than 2 kg were measured by spring scales.

The adequacy of the diet was estimated based on the Recommended Daily Allowance (RDA) and Dietary Reference Intakes (DRI), according to the age of the children. For the reason of comparison with other studies, figures are shown for those children no longer being breastfed at the time of the study. Because of extreme values, either the trimmed mean or an individual correction of those values was performed for the following calculations of nutritional intake.

5.2.2.2.2 Results

According to the RDA requirements **energy intake for the age** was found to be marginally adequate during the entire study period (mean) for the non-oedematous children and inadequate for the oedematous children. The differences between both groups were statistically significant, with the oedematous children having lower adequacy rate than the non-oedematous children (p=0.0096).

Since in general many of the children were underweight, the energy intake was adequate for their weight in both groups during the study period.

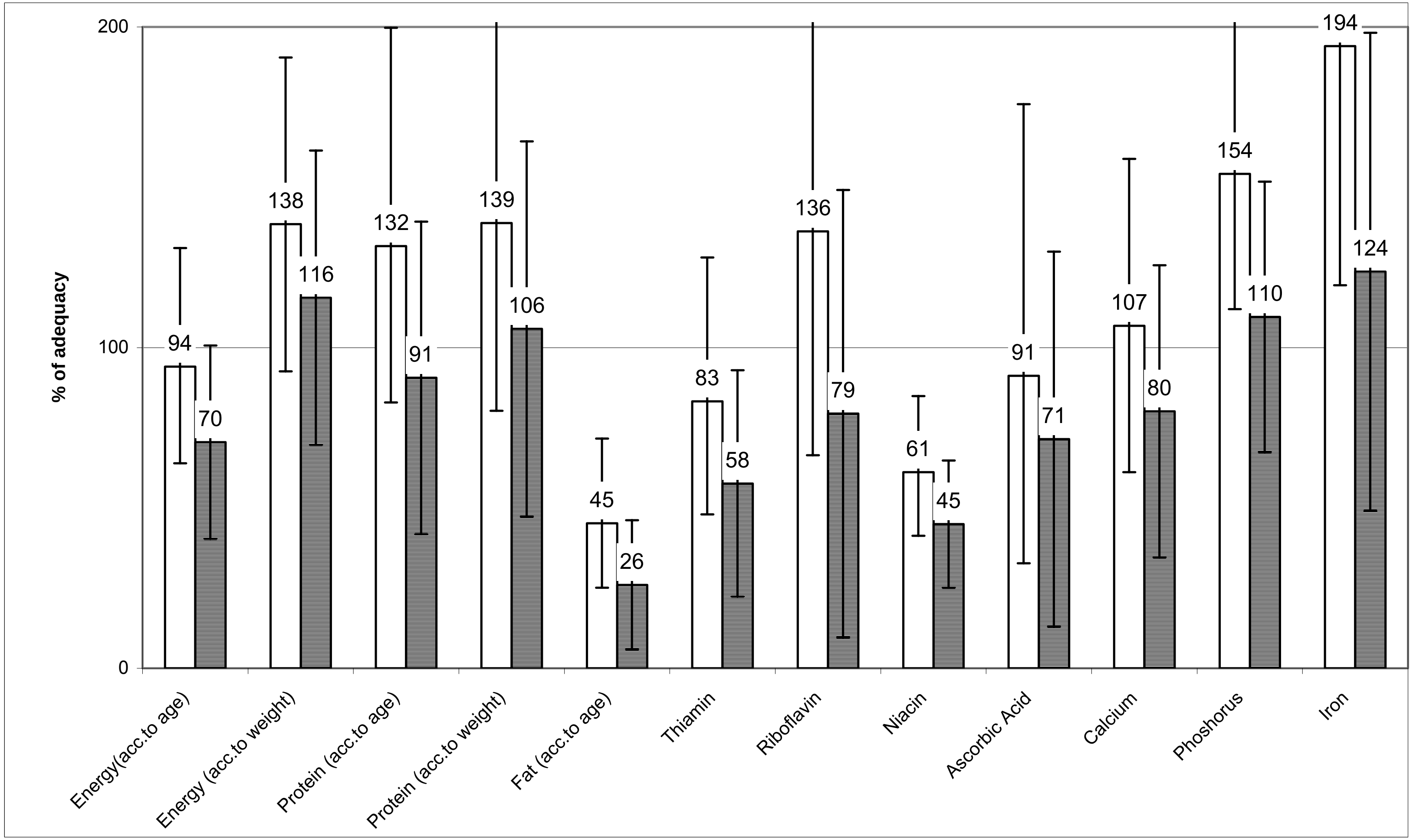

Figure 5 – 7: **Adequacy of the diet (in %) of oedematous (striped bars) and non-oedematous children (white bars) – mean for the entire study period**

The situation for protein adequacy was better for the non-oedematous children. Whereas the non-oedematous children had an adequate intake, the oedematous children had on average a marginally adequate supply of protein (91%) according to their age. The difference of protein adequacy between the groups with respect to age was highly significant (p=0.0005). According to their weight the protein intake was adequate for both groups. Considering that vegetables, maize and *kocho* were the main sources of protein, the digestibility of this protein was only about 82% of the reference protein (FAO *et al.* 1985).

The supply of fat was extremely low, thus deficient in both groups, but on average the oedematous children had a highly significant lower adequacy rate than the non-oedematous children (p=0.0024). Since vegetable oil was used only in very small amounts the low fat intake measured derived more or less from the staple food.

The non-oedematous group took in phosphorus, calcium, iron and riboflavin in abundance. Also the vitamin C supply was satisfactory for the non-oedematous children. The main proportion of calcium, iron and vitamin C were derived from *gomen*, which was consumed daily especially in the healthy children. Although iron rich foods, such as meat, eggs and poultry were consumed in a very small amount, due to the regular consumption of *gomen* and *ensete* iron adequacy was more than 100% in both investigated groups, even though the oedematous children had a highly significant (p= 0.000) lower iron adequacy than the non-oedematous group. Considering that the diet was mainly composed of vegetables and *ensete*, the absorption of iron might be only 5%. With the exception of phosphorus and iron, the oedematous children did not meet the requirements for the other investigated micronutrients and vitamins. The adequacy rate for thiamine, riboflavin, niacin, calcium, and phosphorus was significantly lower than that of the non-oedematous children (p=0.0014, p=0.000, p=0.003, p=0.032, p=0.0024 respectively).

The enormous difference in the intake of *riboflavin* between the two investigated groups reflects the extremely limited diet of the oedematous children with *ensete* as the main food. Riboflavin was present in abundance in the diet of the non-oedematous children as a result of higher consumption of *cereals, pulses and milk*, whereas the oedematous children met on average only 79% of their requirement.

Since *ensete* and *kale* are quite rich sources of calcium, these food items were the most important calcium sources for the children in this sample. Despite this the calcium supply for the oedematous children was not enough, resulting from the low intake of milk or milk products. The most important sources of Vitamin C in the diet of the sample were *gomen* and green pepper. From the adequate ratio of both investigated groups it can be concluded that the consumption of these foods was less in the oedematous children, but not to a significant extent.

When the groups were divided according to the **clinical classification at hospital**, it has to be taken into account that most of the children who became oedematous after discharge from the hospital were former kwashiorkor children. The recuperation of the marasmic children was much more effective, thus cannot reflect the reality of a child being marasmic at the time of food intake.

The adequacy ratios of all nutrients (Table 5–20 and Table 5–21), with the exception of Vitamin C were significantly different between control, kwashiorkor and marasmic children. The ex-kwashiorkor and ex-marasmic children did not meet their energy requirements, and the ex-kwashiorkor children had a marginally adequate supply of protein. The adequacy of fat was not sufficient in any group with the lowest ratio for the ex-kwashiorkor children. The adequacy differences between the groups were significant ($p<0.05$), with the control and ex-marasmic groups having more children above the median and the ex-kwashiorkor group having more children below the median. The adequacy ratios for vitamins and micronutrients were more similar for the ex-marasmic children and the ex-kwashiorkor children, with the latter having the lowest ratios for most of the nutrients. The calcium and vitamin C adequacy ratios were especially low in the ex-marasmus group. More children of the ex-kwashiorkor children had an adequacy ratio of thiamine below the median, compared to the ex-marasmic and control groups having more children with a ratio above the median. In general the adequacy ratios for the B vitamins investigated were the lowest for the ex-kwashiorkor group.

Table 5 – 20: Adequacy of the diet (in %) for main nutrients during one year, ex-PEM children and controls

Clinical classification		Energy (acc.to age)	Protein (acc. to age)	Fat
Control	Mean	121.7	183.9	65.2
n=21	SD	38.1	72.7	26.4
	Median	120.8	175.8	70.2
ex-Kwashiorkor	Mean	73.1	93.3	28.5
n=54	SD	28.6	41.1	18.3
	Median	68.3	92.7	28.0
ex-Marasmus	Mean	88.3	128.8	42.3
n=11	SD	26.2	61.1	24.8
	Median	89.9	120.1	44.4

Table 5 – 21: Adequacy of the diet (in %) for vitamins and micro-nutrients during one year, ex-PEM children and controls

Clinical classification		Ascorbic acid	Niacin	Thiamine	Riboflavin	Calcium
Control	Mean	102.2	74.3	109.2	183.7	144.8
n=21	SD	85.1	22.9	118.4	147.9	42.6
	Median	80.2	77.2	104.8	156.7	140.8
ex-Kwashiorkor	Mean	85.1	48.9	61.4	93.3	84.5
n=54	SD	79.9	19.9	31.2	67.7	47.9
	Median	62.2	44.8	58.9	84.0	80.8
ex-Marasmus	Mean	51.1	55.9	81.4	133.0	79.2
n=11	SD	27.1	25.9	52.5	180.6	34.5
	Median	51.6	48.7	69.1	85.9	84.4

Table 5-22 shows that the diet of **post-kwashiorkor and post-marasmic children** did not significantly differ with respect to the intake of main nutrients. The supply of protein was marginal, whereas the energy supply was insufficient. The fat intake in both groups was far below the daily recommendations.

Table 5 – 22: Adequacy of the diet (in %) for main nutrients during one year, post-kwashiorkor and post-marasmic children

Clinical classification		Energy (acc.to age)	Protein (acc. to age)	Fat
Post-Kwashiorkor	Mean	79.9	99.0	29.2
n=12	SD	37.0	62.1	27.4
	Median	68.2	87.3	25.9
Post-Marasmus	Mean	76.9	103.7	32.8
n=23	SD	26.6	50.2	20.8
	Median	72.8	98.1	29.9
Significance p=		n.s.	n.s.	n.s.

Concerning the intake of vitamins and micro-nutrients, children from both groups did not meet the requirements of the B-vitamins under study (Table 5-23), with the kwashiorkor children having an especial low intake of thiamine (p=0.044) and niacin. Not even 50% (median) of the recommended intake was fulfilled throughout the year of investigation. The Table also shows that the post-marasmic children had a lower intake of vitamin C (ascorbic acid) and especially calcium.

Table 5 – 23: Adequacy of the diet (in %) for vitamins and micro-nutrients during one year, post-kwashiorkor and post-marasmic children

Clinical classification		Ascorbic acid	Niacin	Thiamine	Riboflavin	Calcium	Iron
post-Kwashiorkor	Mean	98.6	48.3	57.5	103.0	104.0	155.7
n=12	SD	65.4	21.6	40.4	91.7	48.9	101.9
	Median	82.8	40.8	49.5	80.2	98.3	121.2
post-Marasmus	Mean	86.6	53.4	74.6	96.4	79.1	161.8
n=23	SD	81.4	24.2	40.2	131.7	50.2	164.3
	Median	59.1	48.6	70.0	81.7	63.8	132.4
Significance		n.s.	n.s.	0.044	n.s.	n.s.	n.s.

Seasonal influences

Annex A 5-1 to Annex A 5-3 give an overview of the seasonal influences on the intake of various nutrients according to the different classifications.

There were strong seasonal patterns for the adequacy of nutrient intake for all children, but the differences between the seasons for the oedematous children were tremendous (Annex A 5-1). In the pre-harvest season from April to July the adequacy ratios of macro- and micronutrients were the lowest, with a peak of adequacy for nearly all nutrients in the coffee-season from August to November and a decrease of adequacy in the post-coffee season. But, whereas the adequacy of most nutrients between the coffee-season and the post-coffee season fell only slightly for the non-oedematous group, it decreased nearly to the ratios of the pre-harvest season in the oedematous group. Adequacy ratios for iron, phosphorus and niacin were even below the ratios of the pre-coffee season. As mentioned already above, it has to be born in mind that the absorption of iron might be only about 5% because of the composition of the diet. Thus, the most significant differences between oedematous and non-oedematous groups were found in the post-harvest season from December to March. With exception of the vitamin C ratio, the adequacy ratios of the oedematous children were significantly lower than those of the non-oedematous children for all other nutrients in this season. Therefore, the oedematous children suffered from inadequate intake of most of the nutrients for a time period of about 8 months (December to July) of the year.

Annex A 5-3 gives information on the children who suffered from kwashiorkor (post-kwashiorkor) and marasmus (post-marasmus) after discharge from hospital. The post-kwashiorkor group had a better supply of all nutrients during the coffee-season. As with the group of oedematous children, the post-kwashiorkor children had a deficient supply of several nutrients over a long period of time (about 8 months), especially fat, thiamine, niacin and vitamin C. Concerning the post-marasmic children, the energy intake was much too low throughout the year, even in the coffee-season, but with all other nutrients and micro-nutrients investigated they were better off in the post-harvest season than the post-kwashiorkor children. The thiamine intake in this season was significantly higher and the iron-intake was weakly significantly higher than the intake of the post-kwashiorkor children. On the other hand calcium intake

was extremely low for the marasmic children. Especially in the pre-coffee season the intake was highly significantly lower than that of the post-kwashiorkor children.
Differences between the adequacy ratios were more significant if the sample was divided into the classification done at hospital. Annex A 5-2 gives an overview of the adequacy ratios of former control children, ex-kwashiorkor and ex-marasmic children. Since most of the oedematous children were relapse cases and only a smaller part of the control and ex-marasmic children became oedematous later, the diet of oedematous and ex-kwashiorkor children were quite similar. The adequacy ratios of the non-oedematous group were all below those of the former control group, since in the non-oedematous group the ex-marasmic and ex-kwashiorkor patients, who did not get nutritional oedema after discharge from hospital, were also included.

Throughout all seasons the ex-kwashiorkor children had the least adequate intake of energy, protein, fat, phosphorus, iron, thiamine and riboflavin compared to the ex-marasmic and control children. The ex-marasmic children were especially inadequate in their intake of Vitamin C, which was on average lower than this of the ex- kwashiorkor and even of the oedematous children throughout the year, but differences were not found to be significant. An explanation for this could be the small sample size of ex-marasmic patients. Also the calcium adequacy was the lowest for the ex-marasmus group in the pre- and post-harvest seasons.

Food intake according to the age

As reported in former studies the most vulnerable age for getting kwashiorkor is when the mother stops breastfeeding and adequate weaning food is not given which occurs mostly in the child’s second or third year of life. Thus, a comparison of energy intakes according to the age of the oedematous and non-oedematous children is summarised in Figure 5–8.

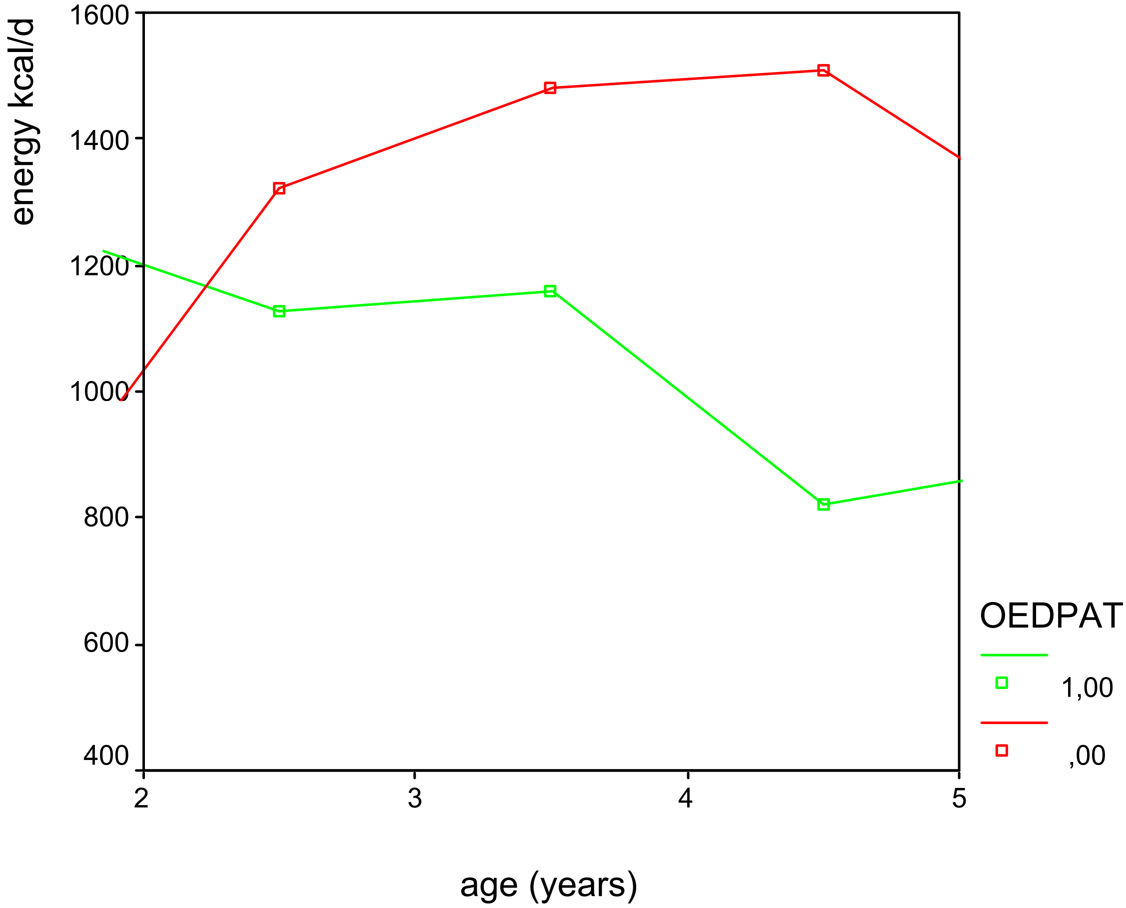

Figure 5 – 8: Energy intake (Kcal/d) according to the age of the oedematous (oedpat=1) and non - oedematous (oedpat=0) children

The Figure demonstrates, that in this sample between the second and third year of life the daily energy intake of the oedematous children was importantly below the intake of the non-oedematous children. This pattern results from the fact that the mothers of the index children were usually breastfeeding until the children were 2 years of age. After stopping breastfeeding the children depended totally on the unbalanced food prepared and served by the caregiver. The figure also shows that the situation worsened when the child reached the 4th year of life. At this age children are expected to be old enough to generate self-survival strategies.

CA/P- ratio

Especially problematic for the non-breastfed children was the quality of the food with respect to calcium. A Ca/P ratio of 1.33 for children aged from 1 to 6 years is recommended. If the ratio is low, the supply of some important nutrients such as calcium, zinc, iron and magnesium might be low because of the high content of phytate in the food (PRENTICE and BATES 1994). Since the supply of phosphorus was comparably high to the calcium supply, a low Ca/P- ratio was calculated for all children throughout the year. The oedematous children younger than 6 years had a mean Ca/P ratio of 1.34, the median was 1.24. The non-oedematous children had a Ca/P ratio below 1.33 (mean 1.15, median 1.06). The slightly lower ratio of the non-oedematous children can be explained by the heterogeneous composition of this group. The former marasmic children had the lowest Ca/P ratio (mean: 0.82, median: 0. 63). Most of them belonged to the non-oedematous group. The former controls had a ratio near the cut-off point (mean: 1.32, median: 1.30). The former kwashiorkor children, who made up the highest proportion of the oedematous group, had a ratio of 1.24 (mean) and1.21 (median).

The post-kwashiorkor children (n=12) had a Ca/P ratio lower than the cut-off point only in the coffee-season (pre-coffee season: mean: 1.7, median:1.5; coffee-season: mean: 1.0, median: 1.0, post-coffee season: 2.2, median: 1.8). For the post-marasmic children the ratio was throughout all seasons lower than the cut-off point (pre-coffee season: mean:1.0, median: 0.9; coffee-season: mean: 1.0, median: 0.7, post-coffee season: 1.1, median: 1.0)

P/E-ratio

According to Waterlow the P/E (Protein/Energy) ratios in the diets of children no longer exclusively breastfed provides a good way of looking at the adequacy of protein intakes. The safe level for the P/E ratio of a one year old child is unlikely to be greater than 6.5% or less than 5.0% (WATERLOW, PAYNE 1975). The problem, however, lies with the individual variability of requirements. The P/E ratio in breast milk is about eight; as growth falls off the level of P/E will decrease to about six. (SCRIMSHAW and WATERLOW 1994). In Whitehead’s studies in Gambia and Uganda, P/E ratios were measured in the diets of individual children during the second and third year of life (WHITEHEAD *et al.* 1976). In the Gambia where diets are cereal based, the ratios were very similar in the diets of all children, with an average of about eight. In Uganda there was a much wider scatter and about 10% of children had diets with a ratio of five or less, which indicated a risk of protein deficiency. Interestingly at that time, kwashiorkor was more common in Uganda than in The Gambia.

Table 5-24 gives an overview of the percentage of oedematous and non-oedematous children lying below the P/E ratio of 5 and thus being in danger of protein deficiency. Considering that vegetables, maize and *kocho* were the main sources of protein, the digestibility of this protein was only about 82% of the reference protein (FAO *et al.* 1985). Taking this into consideration, figures of this study show that throughout the year at least 10% of the children were at risk of protein deficiency, but in the pre- and post-coffee harvest seasons a much higher percentage of children were in danger of being deficient in protein.

In the pre- and post coffee seasons, about 50% of the oedematous children had a P/E ratio below the cut-off point compared to about 30% of the non-oedematous group. In the coffee harvest time the number of children falling under the 5% level was decreasing markedly for the oedematous children (11%). The mean P/E ratio in this season was comparable to that of the non-oedematous children, whereas during the rest of the year the oedematous children had a much lower P/E ratio than the healthy children with the lowest ratio in the pre-coffee time from April to July (p=0.002).

Table 5 – 24: P/E-ratio of diets in oedematous (O) and non-oedematous (NO) children in the various seasons

	April-July		**August-November**		**December to March**	
P/E ratio	O % n=28	NO % n=78	O % N=28	NO % n=78	O % n=28	NO % n=78
< 5%	50.0	27.1	11.1	22.4	48.1	30.2
5-6.5%	26.9	22.9	40.7	27.6	22.2	26.4
>6.5%	23.1	50.0	48.1	50.0	29.6	43.4
Mean P/E Ratio	5.14±2.20	6.50±2.25	6.64±1.68	6.53±1.95	5.77±3.02	6.30±2.21

As can be seen in all other chapters the post-kwashiorkor patients ate a more nutritious diet concerning both quantity and quality in the coffee-season than in the pre- and post-harvest season. Especially in the pre-harvest season the P/E ratio (Table 5

–25) was very low for the post-kwashiorkor children. More than 80% of the children had a P/E ratio below the cut-off point compared to about 30% of children in the post-marasmus group. The differences between the classes were highly significant (p=0.009). Also in the post-coffee season about 60% of the kwashiorkor children had a P/E ratio below the cut-off point. The mean P/E ratio for the pre-harvest season was statistically highly significant (p=0.004), with the ratio being lower for the post-kwashiorkor children. Only in this season was the mean P/E ratio lower than the recommended cut-off point. For all seasons the ratio was smaller for the post-kwashiorkor than the post-marasmic patients.

Table 5 – 25: P/E-ratio of diets in post-kwashiorkor and post-marasmic children in the various seasons

	April-July		**August-November**		**December to March**	
P/E ratio	p-K % n=12	p-M % n=23	p-K % n=12	p-M % n=23	p-K % n=12	p-M % n=23
< 5%	83.3	28.6	16.7	21.7	58.3	31.8
5-6.5%	-	19.0	58.3	26.1	8.3	22.7
>6.5%	16.7	52.4	25.0	52.2	33.3	45.5
Mean P/E Ratio	4.09±1.93	6.36±2.13	5.97±1.17	6.49±1.95	6.28±4.19	6.39±2.40

Protein quality of the diet – absolute daily intake of essential amino acids

Protein quality depends on the proportion and pattern of the essential amino acids. The essential amino acid requirement for tissue maintenance is relatively low, because recycling of these amino acids is extremely efficient. For growth however, the essential amino acids have to be provided by the diet for deposition in tissue protein Annex A 5-4 gives an overview of the mean absolute intake of the different amino acids in oedematous and non-oedematous children. Concerning the calculation of amino acid intake it has to be taken into consideration that in the nutrition tables of Ethiopia there is in general a too high content of amino acids in the foods. After proportion correction of the values, the figures calculated can only be seen as an estimation of intake. However, the results listed in Annex A 5-4 show that there were differences in the intake according to the groups of observed children. For nearly all amino acids the intake was much lower for the oedematous children, also for the sulphur-containing amino acids cysteine and methionine, the main nutritional derivations of glutathione (HUXTABLE 1986). Circulating levels of methionine are shown to be grossly diminished in kwashiorkor (EDOZIEN *et al.* 1960; WHITEHEAD *et al.* 1960; AWWAAD *et al.* 1962; ARROYAVE *et al.* 1962; ITTYERAH *et al.* 1965). Moreover a deficiency of sulphur-containing amino acid intake was demonstrated in some former studies (SIMMONS and BOHDAL 1970; BEATON *et al.* 1992). For an exact calculation of the intake of amino acids in a future study amino acids will have to be analysed biochemically from all foods eaten.

The range of energy and nutrient - supply

The adequacy Figures (Figure 5–9 and Figure 5–10) of energy supply and different selected nutrients were divided into three categories: grossly deficient (<40%), deficient (40%-80%) and reasonably good (>80%). The results are shown for the classification done after discharge from hospital in oedematous and non-oedematous children. Only data for children no longer being breastfed is presented.

Concerning the adequacy range of **energy** more than 60% of children from the oedematous group were deficient (40%-80% of adequacy). The differences between the groups were significant (p=0.016).

Under the assumption that the digestibility of the protein in the diet was only about 82% of the reference protein, only about one third of the oedematous children had a reasonably good supply of protein throughout the year, whereas about two thirds of the non-oedematous children were getting more than 80% of their requirement according to their age. The differences between the groups were significant (p=0.02).

As mentioned above, the most striking difference between the two groups was the fat supply (p=0.002). Nearly twice as many oedematous children compared to the non-oedematous children had a grossly deficient intake of fat (86% and 47% respectively) according to the recommendations.

Concerning the range of supply of **micronutrients** important differences between the two investigated groups were found for riboflavin (p=0.001), thiamine (p=0.027) and niacin (p=0.015). About 50% of the oedematous children were deficient and 10% of them were grossly deficient in riboflavin, compared to 80% of the non-oedematous children who had a reasonably good supply of this vitamin. Even more children from the oedematous group were deficient in thiamine. About 50% were in the 40% to 60% category and about 30% were grossly deficient in thiamine. Also about 60% of non-oedematous children did not get adequate amounts of thiamine. Similar were the data for the adequacy of niacin. About 40% of oedematous children had either deficient or a grossly deficient intake of niacin. Not only was the intake of different B vitamins inadequate for a high percentage of oedematous children, but also the Vitamin C intake was insufficient for many children. About 70% of the oedematous and 53% of the non-oedematous children got inadequate amounts of Vitamin C.

Few children with deficient intake of phosphor and iron were observed. On the other hand, a deficient diet was found in 46% and a grossly deficient diet in 11% of oedematous children with respect to calcium. Conversely, about 70% of the non-oedematous children had a reasonably good supply of calcium. The differences between the groups were significant (p=0.045).

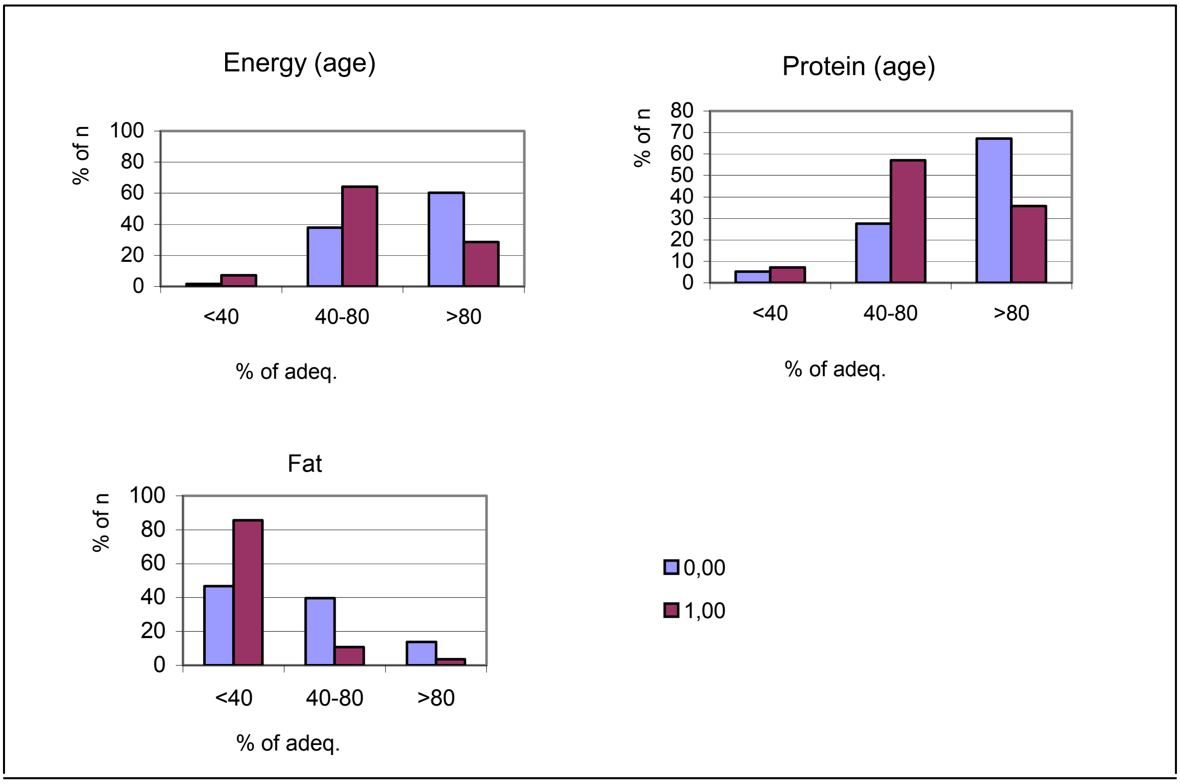

Figure 5 – 9: Percentage distribution of main nutrients
Three classes of adequacy: <40, 40-80, >80,
0=non-oedematous group 1=oedematous group

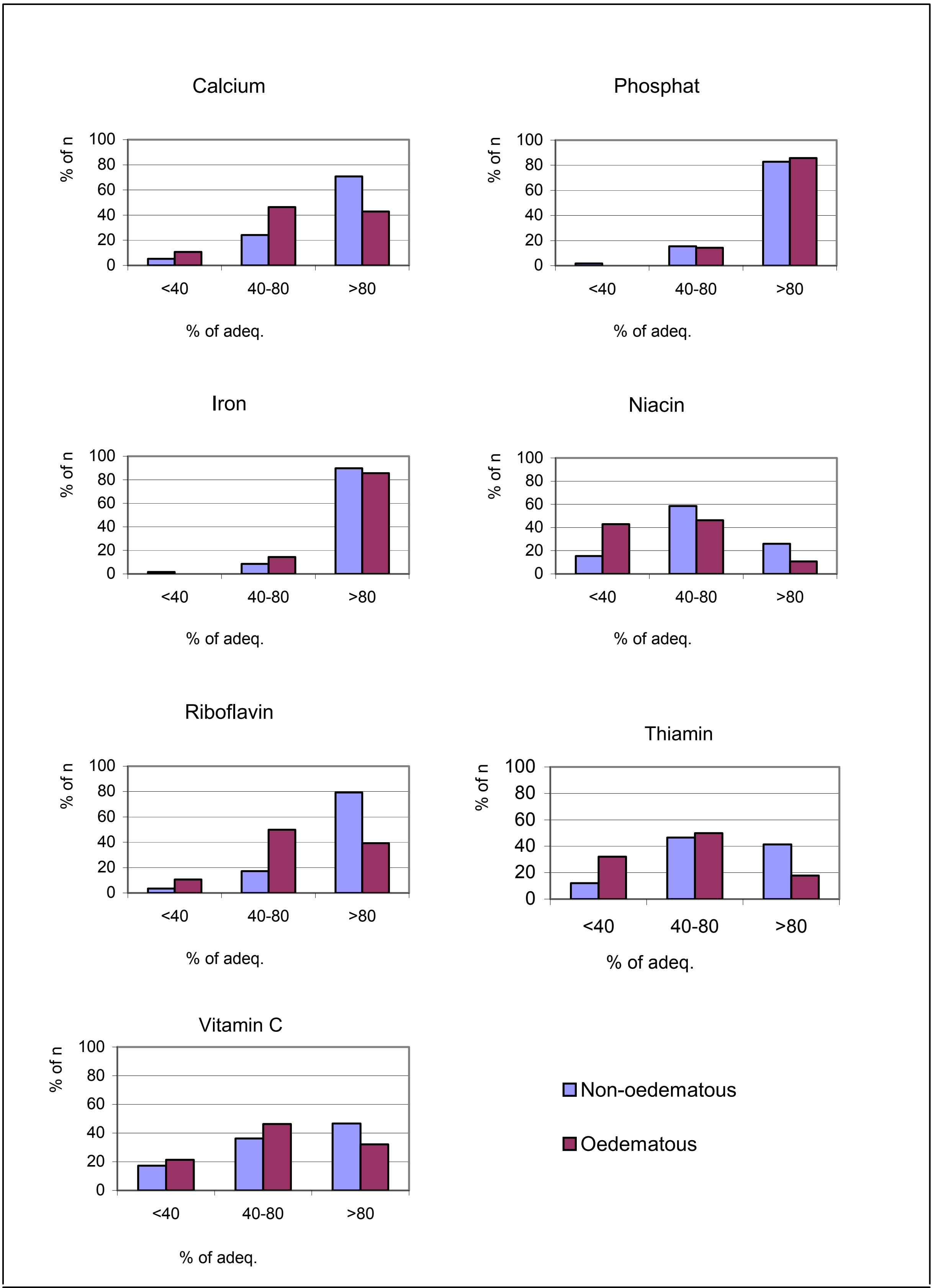

Figure 5 – 10: Percentage distribution of micro nutrients and vitamins
Three classes of adequacy: <40, 40-80, >80

Contribution of calories and nutrients from different food groups

Figures 5-11 and 5-12 reveal the contribution of calories and nutrients from different food groups only for children who were no longer breatsfed. A typical diet of an oedematous and a non-oedematous child in the pre-coffee time may serve as an example for the sample.

The example of the healthy child comes from the direct neighbourhood of the example of an oedematous child. Figures 5-11 and 5-12 clearly show the dominating role of *ensete* in the diet of the oedematous child compared to the healthy child. More than 90% of energy was derived from *ensete* in the diet of the oedematous child. *Ensete* and *gomen* were also the main source of protein and fat. The child got no oil or butter on this day. Since *ensete* is a quite good source of calcium, more than half of the calcium intake came from this food. The same was shown for phosphorus and iron. The vegetable intake (more or less the *gomen*) was the most important source for Niacin and Vitamin C. Figure 5–12 demonstrates that the diet of the non-oedematous child was composed out of different foods. The non-oedematous child got an important part of vitamin C from fruits, in this case from avocado and guava. Maize and foods rich in fat (oil and avocado) were making up an important part of the energy intake. Especially the protein sources were much more diverse than those of the oedematous child. Milk, maize and *gomen* were important protein sources beside *ensete*. The highest part of fat intake was derived from oil and avocado.

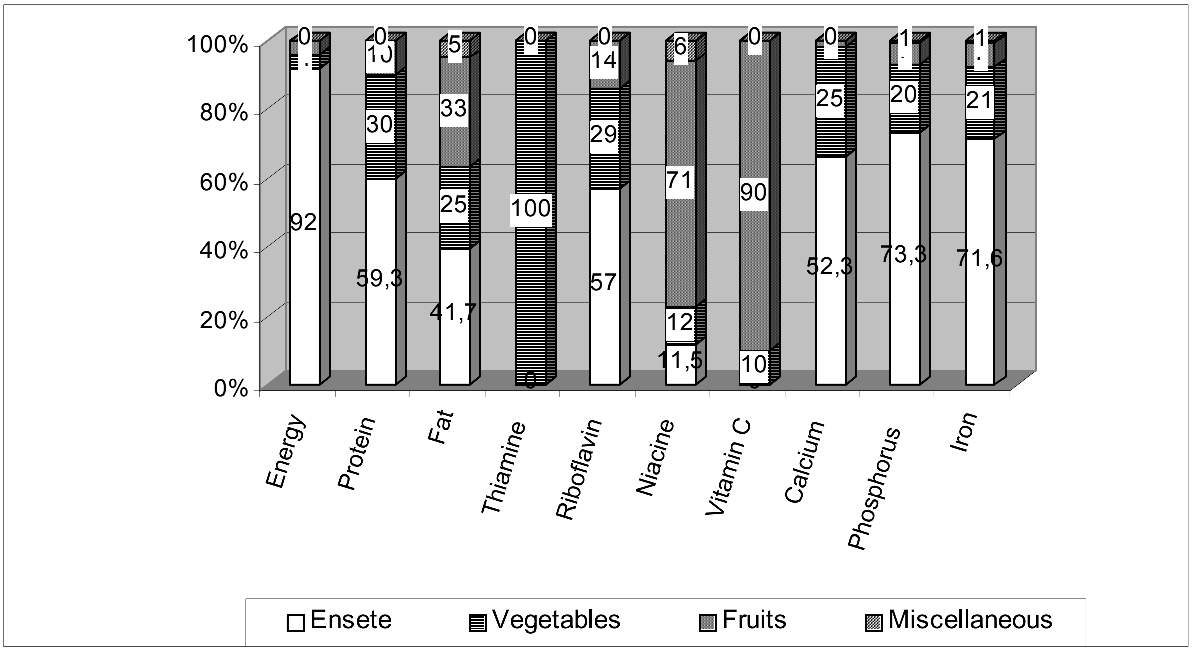

Figure 5 – 11: Contribution of calories and nutrients from different food groups to a typical diet of an *oedematous child* in the pre-coffee season

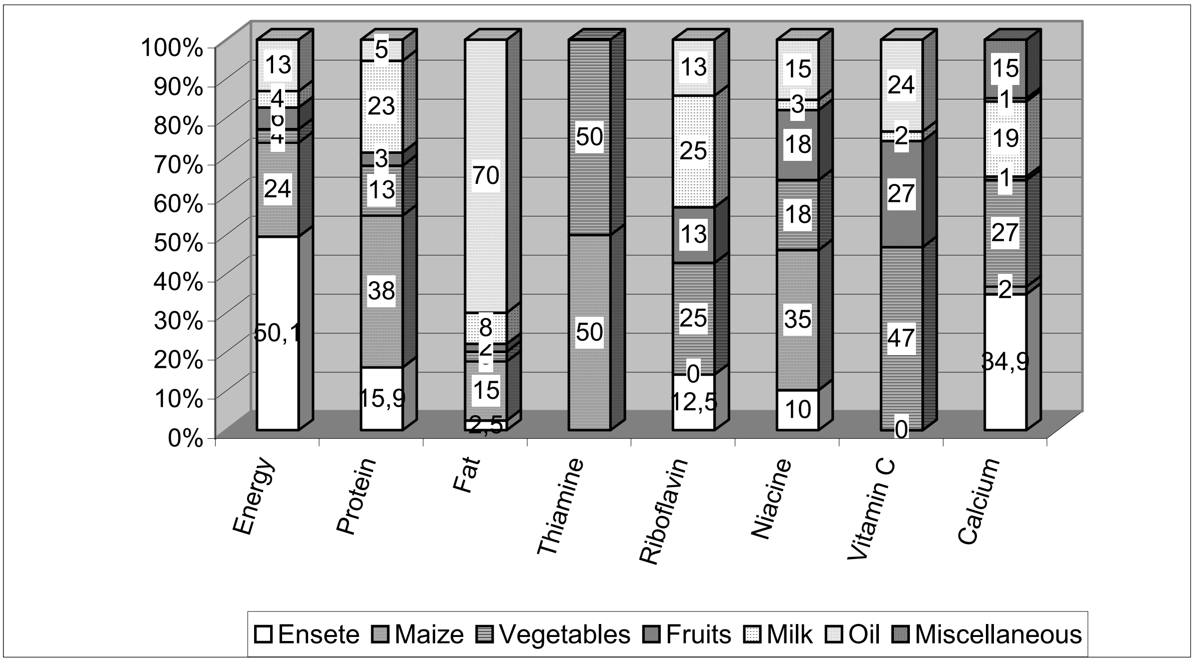

Figure 5 – 12: Contribution of calories and nutrients from different food groups to a typical diet of a *non-oedematous child* in the pre-coffee season

Contribution of main nutrients to the mean daily energy

Figure 5–13 shows that the main part of the energy of the children's diet is derived from carbohydrate, mainly from the dominant role of the starchy food items *ensete* and maize. The percentage of calories from carbohydrate for the oedematous children was higher throughout all seasons than for the non-oedematous children. In the pre-harvest season from April to July the difference of the contribution of carbohydrates to the total energy between the two groups was highest with about 5% (p=0.034, Man-Whitney-U test), decreasing at the post-harvest season to 3% and being nearly 0% in the coffee season. In the healthy group, especially outside the coffee harvest seasons, a higher percentage of calories were derived from fat and protein. The percentage of protein calories to the total energy intake was in all children below 10%, but the oedematous children had a significant lower percentage in the post-coffee season (p=0.017, t-test). The most striking feature was the low contribution of fat to the diet of the oedematous children. The Fat Energy Ratio (FER) is the proportion of dietary energy derived from total fat. Among individual countries, the average FER ranges from 7 to 46 percent. A general guideline is that about 20-35% of calories should come from fat (SAVAGE KING, BURGESS 1992). During weaning and at least until two years of age, a child's diet should supply 30 to 40 percent of energy from fat and should provide essential fatty acids at levels similar to those in breast milk (FNA /ANA 11 1994). A diet should never contain less than 10 percent of calories from fat (SAVAGE KING and BURGESS 1992). The respective data for the oedematous children were below 10 percent throughout all seasons, with the lowest FER in the pre-coffee season (6%). The difference between the two groups was highly significant in the pre-coffee season (p=0.005, Median test) and weakly significant in the post-coffee season (p=0.065, Mann- Whitney-U test). Since fat is necessary for the absorption of fat-soluble Vitamins (Vitamin A, D, E and K) a lack of those Vitamins can be expected especially for the oedematous children.

In general, the non-oedematous children had no important seasonal differences in the contribution pattern of main nutrients to the total energy intake, whereas the oedematous children had important seasonal variations. With the exception of the coffee season, between 85 and 90% of energy was derived from carbohydrates, whereas the percentage deriving from fat and protein was correspondingly low.

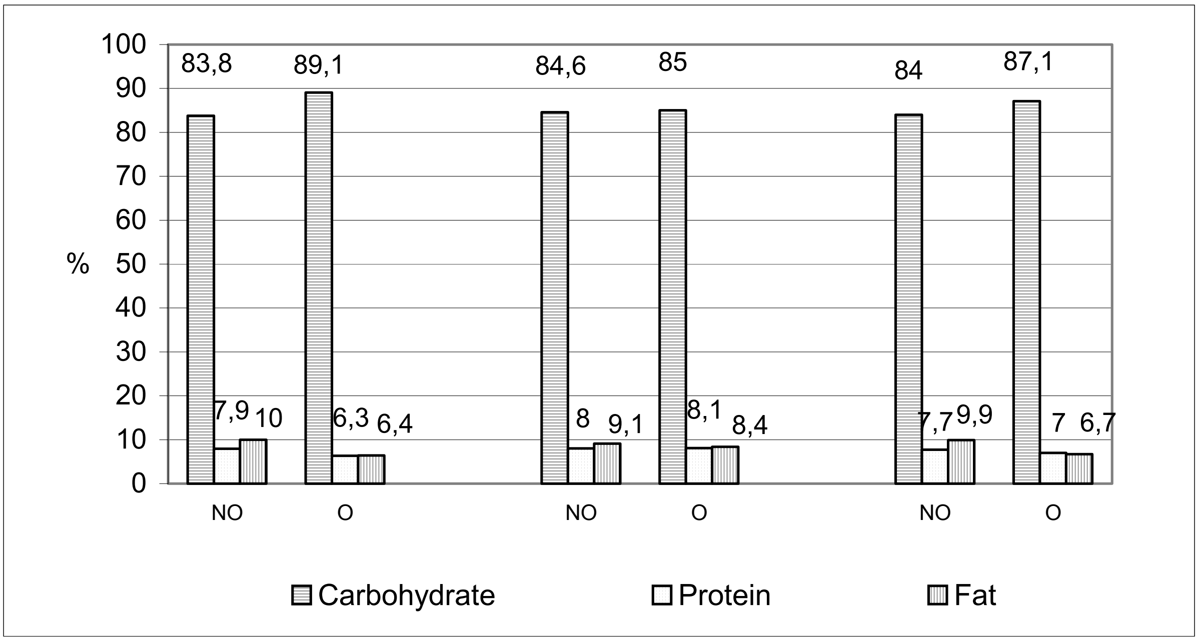

Figure 5 – 13: Mean of percentage distribution of calories from carbohydrate, protein and fat for non-oedematous and oedematous children not breastfed anymore in the various seasons (from left to right: pre-coffee season, coffee season and post-coffee season)

Concerning the post-kwashiorkor and the post-marasmus group the contribution of all nutrients to the total energy intake was significantly different for the pre-coffee season: for carbohydrate: p=0.024, for protein p=0.006 and for fat p=0.044 (n-par test). The mean percentage of carbohydrate calories to the total energy intake was higher for the post-kwashiorkor children than for the post-marasmic children (91.2% and 84.9% respectively, Table 5-26). The protein calories were with 5.0% lower than the protein calories of the post-marasmic children (7.8%) and also the fat calories were lower for the post-kwashiorkor children (5.7% compared to 9.0% of the post-marasmic children). Throughout all seasons the contribution of carbohydrates to the total energy was higher for the post-kwashiorkor children compared to the post-marasmic children, whereas the contribution of fat- and protein calories to the total calories was lower.

Table 5 – 26: Mean of percentage distribution of calories from carbohydrate, protein and fat for post-kwashiorkor (p-K) and post-marasmic (p-M) children not breastfed anymore in the various seasons

	April-July		**August-November**		**December to March**	
	p-K % n=12	p-M % n=23	p-K % n=12	p-M % n=23	p-K % n=12	p-M % n=23
Carbo-hydrate	91.2	84.9	86.2	85.6	86.2	84.1
Protein	5.0	7.8	7.3	7.9	7.7	7.8
Fat	5.7	9.0	8.2	8.0	7.9	9.4

6 ANALYSIS OF DETERMINANTS

6.1 Relations between certain determinants

6.1.1 Relation between the occurrence of illnesses and food diversity in the household and the occurrence of nutritional oedema

Since the occurence of illnesses as well as the food diversity in the household might influence the occurrence of oedema in children, bi-variate logistic regression was performed. According to this analysis the average number of illnesses in the families turned out to be a risk factor for the occurrence of oedema in the families (p=0.013, OR =1.26, 95% CI =1.05 –1.53) and the average number of foods (average over the three seasons) consumed in the household (indicator for food diversity) was found to have a protective impact (p=0.0006, OR=0.68, 95% CI =0.5-0.89).

6.1.2 Relation between per capita income and food diversity

In the frame of the analysis of food choice and ignorance of food in households with malnourished children, especially kwashiorkor, the question arose if there is a relation between per capita income and foods available in the households, measured through the above mentioned food variety scores. For that reason a **correlation** was computed between the per capita income and the total number of foods available in the pre-coffee and coffee season separated for the non-oedematous and the oedematous group. In these two seasons also foods with animal origin were available.

A positive linear correlation for the pre-coffee season and the coffee season in terms of per capita income and foods available during the seasons could not be proved. Even though a positive impact of income on the number of foods available can be seen in each group, it becomes clear through this analysis that in the pre-coffee season, where the range in per capita income was between 20 and 60 Birr, the oedematous group had in general 1-3 foods less available than the non-oedematous group (median:7 and median:10 respectively), as shown by the separate lowest curves in Figure 6–1. According to the non-oedematous group with a per capita income of more than 100 Birr between April and July a saturation point in terms of number of foods available in the household was observed.

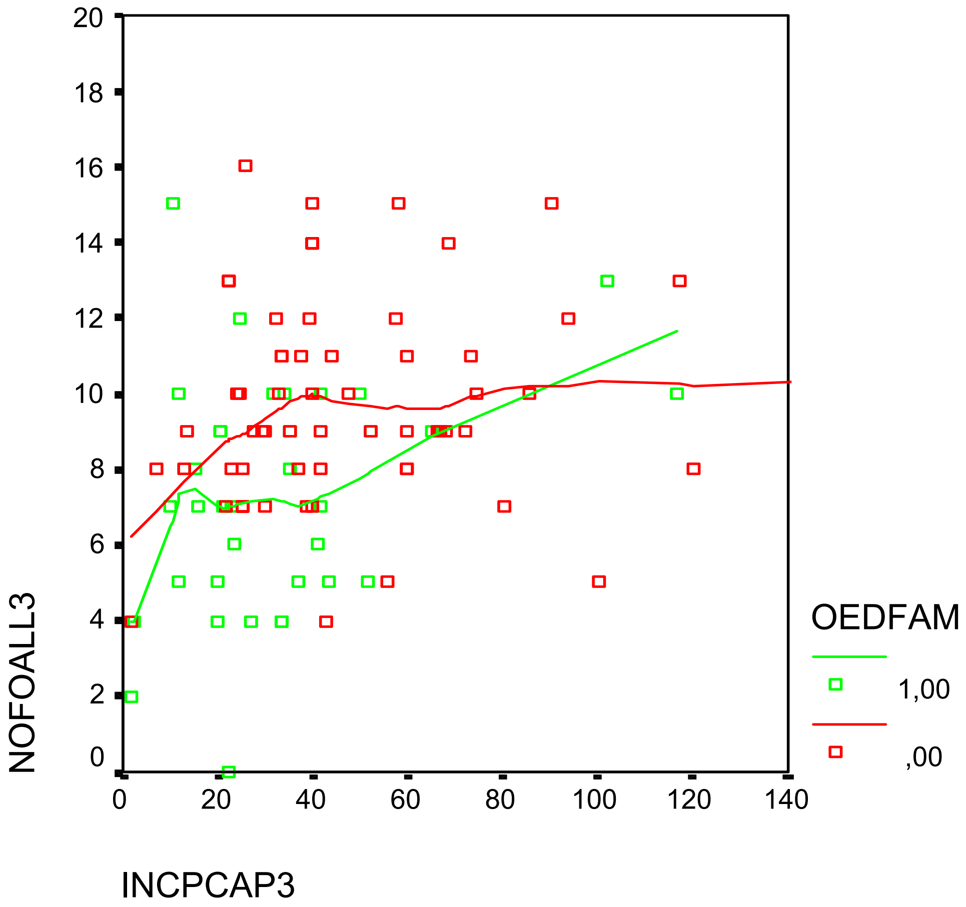

Figure 6 – 1: Scatter plot with local regression of the number of foods available in the pre-coffee season (nofoall3) depending on the per capita income (incpcap3) for households with non-oedematous (0) and oedematous (1) children

The same effect could be observed in the coffee season, with the per capita income level in this season being higher in both groups. On the income level of 20 to 100 Birr per capita the households with non-oedematous children consumed about 12 different foods (median=12), but the households with oedematous only 9 foods (median=9) (Figure 6–2).

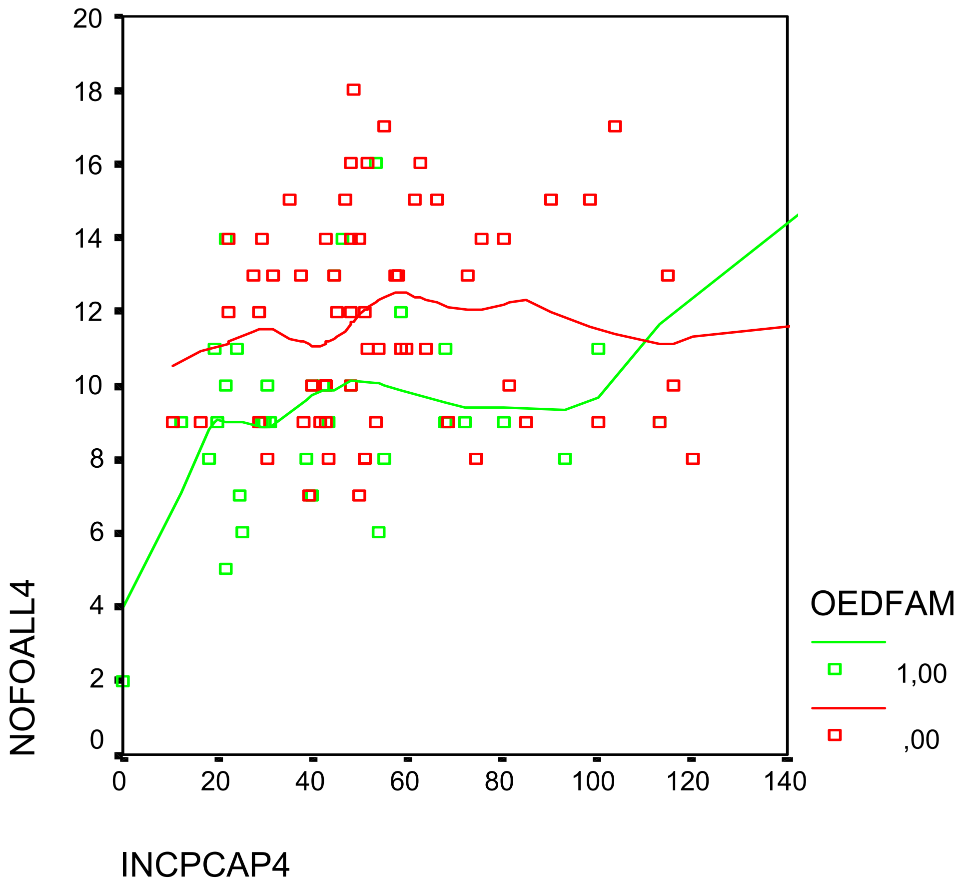

Figure 6 – 2: Scatter plot with local regression of the number of foods available in the coffee season (nofoall4) depending on the per capita income (incpcap4) for households with non-oedematous (0) and oedematous (1) children

It was only in the post-coffee season when a positive correlation (r=0.554, p= 0.000) between the per capita income and the number of foods available in the households could be proved in both investigated groups. The result indicates the important influence of food choice which will be discussed later (Chapter 7).

6.1.3 Relation between per capita income and illness

To analyse if there is a correlation between per capita income and the number of illnesses in the family (with exception of oedema and the typical oedema accompanying symptoms) a Spearman correlation was computed.
There was a significant negative correlation between per capita income and illnesses in the households if the sample was not divided into groups. The higher the income became the less illnesses occurred during the entire study year (r= -0.225, p=0.029) and especially in the pre-coffee season (r=-0.243, p= 0.014). The same impact could be seen if groups were analysed separately, but does not prove to be significant.

6.1.4 Care and its impact on the adequacy rate of food supply

The following results show the correlation between terciles of care and terciles of important nutritional indicators (fulfilment of requirement in fat, energy, protein intake). The analysis was carried out for the whole sample, since the results from the divided groups were similar to those from the whole sample. As demonstrated above, it has to be taken into consideration that nearly no caregiver from the oedematous group was present in the group of best quality of care.

Obviously the better the care was, the better the fulfilment of the requirement of different nutrients for the index children – energy (r=0.653), fat (r=0.585) and protein (r=0.550) respectively. The differences between the groups of adequacy rates were highly significant (p=0.000) in all cases. In Figures 6-3 to 6-5 the relationship between care and the adequacy rate of energy, fat and useable protein was expressed by percentage in each class of adequacy. Through the figures it gets clear that children who got only bad or medium care were over-represented in the lowest classes of adequacy concerning all nutrients. No child who received good care was grossly deficient in protein and none of the children who received bad care got a marginally sufficient supply of energy and fat.

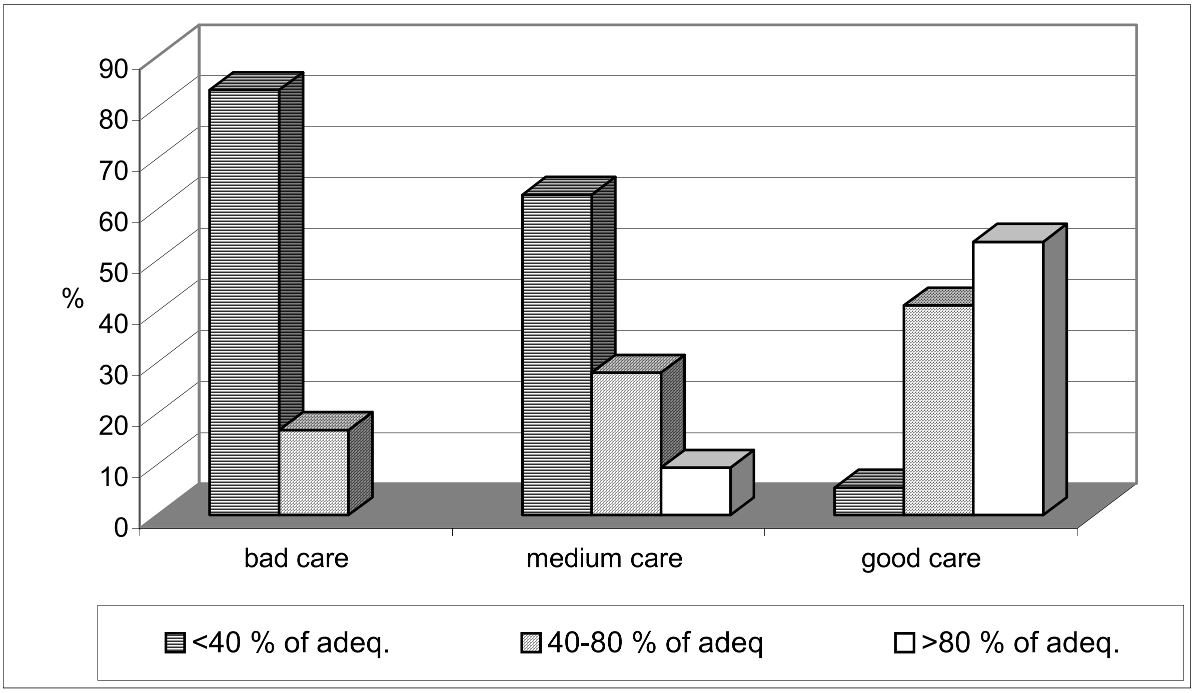

Figure 6 – 3: Relationship between care index and adequacy rate of energy requirement

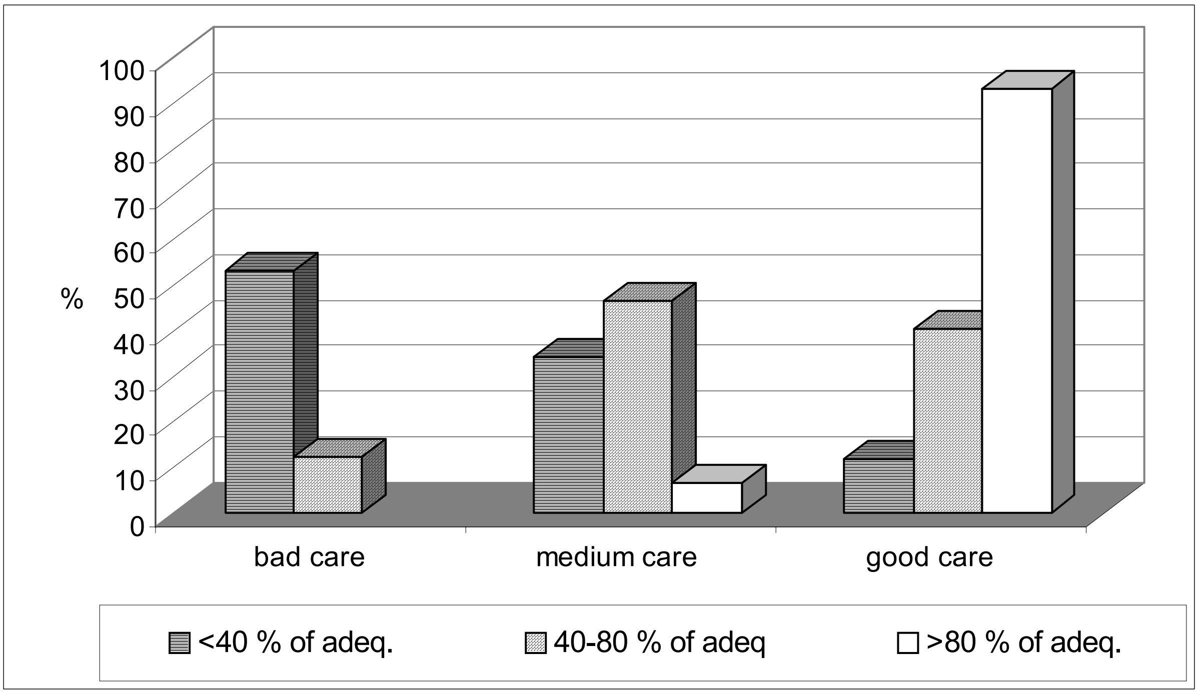

Figure 6 – 4: Relationship between care index and adequacy rate of fat requirement

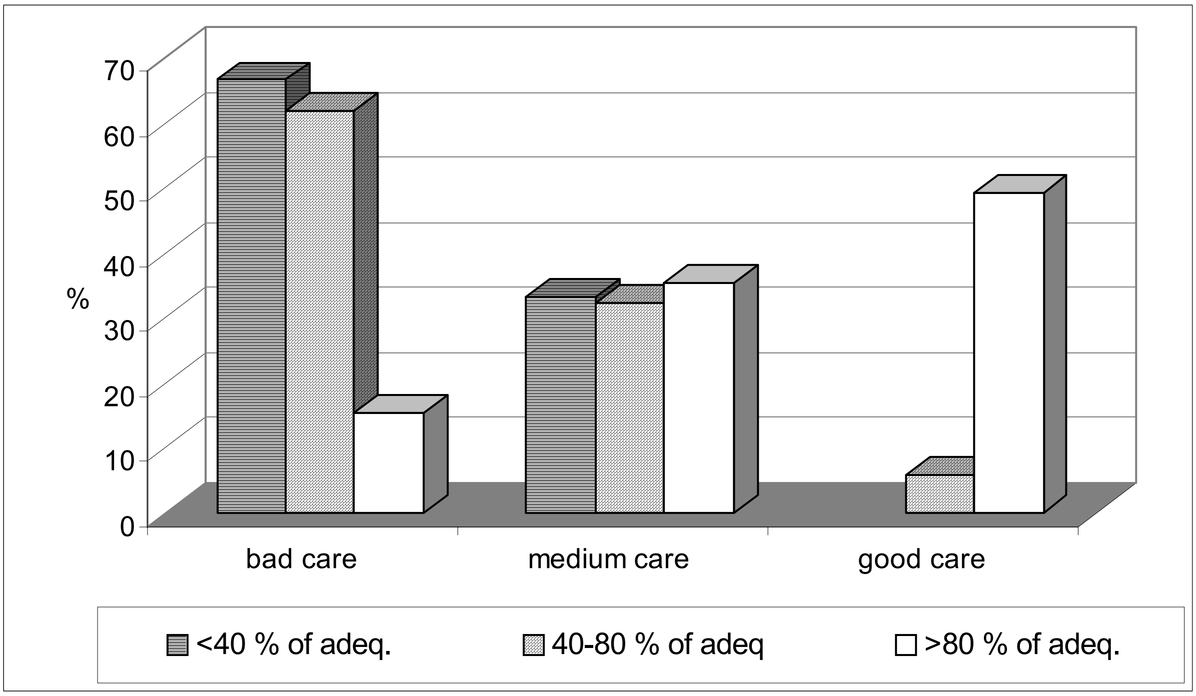

Figure 6 – 5: Relationship between care index and adequacy rate of protein requirement

6.2 Multivariate analysis of determinants - comprehensive logistic regression of variables with significant impact on the occurence of nutritional oedema –

For all of the significant indicators multiple logistic regression was used to compute odds ratios and their 95% confidence intervals as an approximation of relative risk.

Starting model

For selection of the best model with the most important determinants influencing the occurence of nutritional oedema a backward elimination logistic regression was performed. With the logistic regression models those determinants with the highest impact on the nutritional oedema should be pointed out. The backward elimination logistic regression starts with all chosen variables. The variables used were all proven as significant determinants (Spearman's rank correlation) for the occurence of nutritional oedema (see chapters above). Among those variables from one field (e.g. economical background) that were strongly correlated with each other e.g. income, expenditures and expenditures for food, the one with the strongest relationship to the occurence of nutritional oedema was applied. Then, at each step, variables were evaluated for entry and removal (SPSS Regression Models 9.0,1999). An optimal model was applied for the final logistic regression. This was the most parsimonious model among those with optimal prediction for the occurence of nutritional oedema. This method applied for the dependent variable:

Occurence of nutritional oedema in the index children after discharge from hospital

In the following Table all variables are presented which were included in the starting model and which remained in the final logistic regression model.

The number of different foods consumed in the family as a predictor of food diversity (NOKIALLZ) is a variable concerning the entire family. The indices concerning the care for the child are: hygiene index, household organisation index, index of perceived problems in the household and index of caregiver's knowledge of how to feed young children. The education index (EDUCINDX) represents the education of the caregivers for the children (father, mother, grandfather, grandmother, aunt, uncle, step father, stepmother etc.). The possible impact of non-oedematous diseases on the occurence of nutritional oedema were presented by two variables: the mean number of diseases in the index child (GSFRPATO) and the mean number of diseases in other household members than the index child (GSFRFAPO) with the exception of nutritional oedema and accompanying symptoms.

The impact of nutrition on the occurence of nutritional oedema were measured by the following variables: the fulfilment (%) of energy (ENERPCA) and protein (PROTPCAU) requirements, the contribution of fat calories (FATPCEN3) and calories from carbohydrates (CHPCEN3) to total calories (%) in the pre-coffee season from April to July. The impact of the protein quality was measured by the mean total intake of sulphur-containing amino acids (SAAAU). The other amino acids investigated (see Chapter 5.2.2.2.) were also correlated to the occurence of nutritional oedema but were excluded from the final logistic regression analysis because of the strong correlation between the different amino acids. Finally the sulphur-containing amino acids were selected because they are discussed in the background of kwashiorkor. The vitamins selected for this analysis were significantly correlated with the occurence of nutritional oedema and were on average all below the requirements for the oedematous children.

Since in this model the children being breastfed at the time of the study were excluded, only N=75 cases were included in the logistic regression model with data for all measured variables.

Table 6 – 1: Variables entered into the logistic regression in starting and final model corresponding to the dependant variables (OCH: Occurence of nutritional oedema in the index child)

Independent variable	Meaning of variable	Variable OCH Starting model	Variable OCH Final model
NOKIALLZ	Number of different foods eaten in the families	X	X
GSFRFAPO	Mean number of diseases in household members other than the index child with exception of nutritional oedema and symptoms accompanying oedema	X	X
GSFRPATO	Mean number of diseases in the index child with exception of nutritional oedema and symptoms accompanying oedema	X	
HYGINDX	Hygiene index	X	-
HOINDX	Household organisation index	X	-
PROBINDX	Index of perceived problems in the household	X	-
BEHVINDX	Index of mothers behaviour towards index child	X	X
EDUCINDX	Index of education of caregiver and head of household	X	-
KNOWINDEX	Index of caregiver's knowledge of how to feed young children	X	-
ENERPCA	Fulfilment (%) of energy requirement; exact weighing	X	X
PROTPCAU	Fulfilment (%) of protein requirement (digestable protein) ; exact weighing	X	X
FATPCEN3	Contribution of fat calories to total calories (%) in the pre-coffee season from April to July.	X	X
CHPCEN3	Contribution of carbohydrate calories to total calories (%) in the pre-coffee season from April to July.	X	-
SAAAU	Mean of absolute intake of sulphur-containing amino acids throughout the year	X	X
VITB1PCA	Fulfilment (%) of thiamine requirement; exact weighing	X	-
VITB2PCA	Fulfilment (%) of riboflavin requirement; exact weighing	X	-
NIACPCA	Fulfilment (%) of niacin requirement; exact weighing	X	-
CAPCA	Fulfilment (%) of calcium requirement; exact weighing	X	-

Final model

The models of the backwards elimination have then been used for the final logistic regression which gives information on the probabilities predicted by the determinants. Only the variables from the most parsimonious model among those with optimal prediction for the occurence of nutritional oedema were applied.

Variables significant for the occurence of nutritional oedema as printed in Table 6–3 were included in the final logistic regression model according to the optimal model among those with the highest prediction of the backward elimination logistic regression analysis. Table 6–2 gives an overview of the correctly predicted cases for the final model of the dependent variable. It can be seen that n= 43 children without oedema were correctly predicted by the model not to have nutritional oedema. Similarly, n= 20 children with nutritional oedema were correctly predicted to have nutritional oedema. The off-diagonal entries of the Table tell how many children were not correctly classified. A total of n=12 children were incorrectly classified in this model. Overall 84.0% of the children were correctly classified in contrast to a correct classification of 65.3% of the children by just predicting that no one got nutritional oedema (null model).

Table 6 – 2: Classification table of the final model of index children with nutritional oedema

	Predicted		**% of correctly predicted**
Observed	Non-oedematous n	Oedematous n	
Non-oedematous n	43	6	
Oedematous n	6	20	
Total percent			84.0

The determinants with the highest impact on nutritional oedema are listed in Table 6 –3 resulting from the optimal model among those with the best prediction. Not all determinants listed in the Table were eliminated by the procedure. They all make an important contribution to the prediction of nutritional oedema, even though not all have a significance level of $p < 0.05$. **B** is the coefficient of the predictor in the logistic regression. The exponential of **B** is a factor, which describes the increase (>1) or decrease (<1) of the risk of becoming oedematous, if the independent variable increases by one unit. For example, if the food diversity (NOKIALLZ) in the household would be increased by one food item, the risk for becoming oedematous decreases by a factor of 0.653. If one non-oedematous disease more would occur in household members other than the index child (GSFRFAPO), the risk for the index child to get nutritional oedema increases by a factor of 1.476 (Table 6–3).

Table 6 – 3: Important determinants for the occurence of nutritional oedema in the index children, significance level, Exp (B) and 95% confidence interval (CI), determinants from the optimal model under those with the best prediction

Variable	Regression coefficient (B)	Significance level p=	Exp (B)	CI 95 % of Exp (B) lowest – highest value
NOKIALLZ	-0.426	0.042	0.653	0.433 – 0.985
ENERPCA	0.051	0.075	1.053	0.995 – 1.114
FATPCEN3	-0.265	0.020	0.767	0.614 – 0.958
PROTPCAU	0.032	0.192	1.032	0.984 – 1.083
GSFRFAPO	0.389	0.018	1.476	1.070 – 2.03
BEHAVINDX	-0.674	0.007	0.510	0.312 – 0.832
SAAAU	-6.424	0.022	0.002	0.000 – 0.404

Significance level p<0.05

According to the final logistic regression model the determinant with the strongest impact on the occurence of nutritional oedema was the behaviour of the caregivers concerning childcare (Wald test in the logistic regression p=0.007). The behaviour index describes the ability of the caregiver to control hygiene as well as the nutrition of the child (see Chapter 4.7.3.2). In addition, the index contains information about the circumstances that affect the caregivers caring ability for the index child (activity of caregiver, illness of caregiver, preferences for other children in the household etc.). The low behaviour index of the caregivers of oedematous children cannot be explained by the low education of the parents, since there was no correlation between the behaviour index and the education index.

Another important risk factor for the occurence of kwashiorkor was the occurence of non-oedematous diseases in the household of the index child. If one more illness in the family occurs, the risk for the index child to develop nutritional oedema increases by the factor 1.476.

Concerning the impact of nutritional items on the occurence of nutritional oedema, the strongest item was the fat energy ratio (proportion of dietary energy deriving from total fat) (p=0.020). As mentioned above the oedematous children had throughout the year an FER between 6% and 8%, far below the recommended ratio. The second nutritional item having a strong impact on the occurence of nutritional oedema was the quality of protein, with the absolute intake of sulphur-containing amino acids – item: SAAAU - reflecting the protein quality. The result of this model reveals the fact that the quality of protein (p=0.022) was a more important determinant in the occurence of nutritional oedema than the quantity of protein (item: PROTPCAU: p=0.192), although the quantity seems to play an important role because it was not removed from the model. The fulfilment of protein requirement and energy requirement both remained in the model but were not significant. Fulfilment of the energy requirement which was only significant under the 10% significance level, seems to be more important than the fulfilment of the protein requirement. As already described in chapter 5.2.2.2.2 there was a low energy intake especially during the season before and after the coffee harvest. A lower intake of sulphur-containing amino acids in children with nutritional oedema was shown in Chapter 5.2.2.2.2. Moreover, according to this model this determinant turned out to be one of the most important risk factors for the illness. If the children with oedema would have the same intake of sulphur-containing amino acids than the non-oedematous children, the risk for the occurence of nutritional oedema would decrease by a factor of 0.156.

For the prevention of nutritional oedema it seems to be of high importance that there is a balanced food diversity available in the household. The predictor of food diversity (NOKIALLZ) in the household of the index child turned out to be a significant risk factor for the occurence of nutritional oedema (p=0.042).

Predicted Probability and Risk Classes for the Occurence of Nutritional Oedema in this Sample

The factors from the final model can be combined to the following regression equation:

Z = -1.147 – 0.426*NOKIALLZ + 0.051 * ENERPCA + 0.032 * PROTPCA - 0.265*FATPCEN3 – 6.424*SAAAU+ 0.389 *GSFRFAPO – 0.674 *BEHVINDX

The predicted probability for a child to get nutritional oedema was computed by the formula

P= e hochz/ 1+ e hochz

To build risk classes for the occurence of nutritional oedema the probabilities derived by logistic regression were discretized by steps of 0.05 (Figure 6 - 6).

The diagram shows the absolute frequency of these discretized probabilities divided into groups of the occurrence of nutritional oedema for the index child.

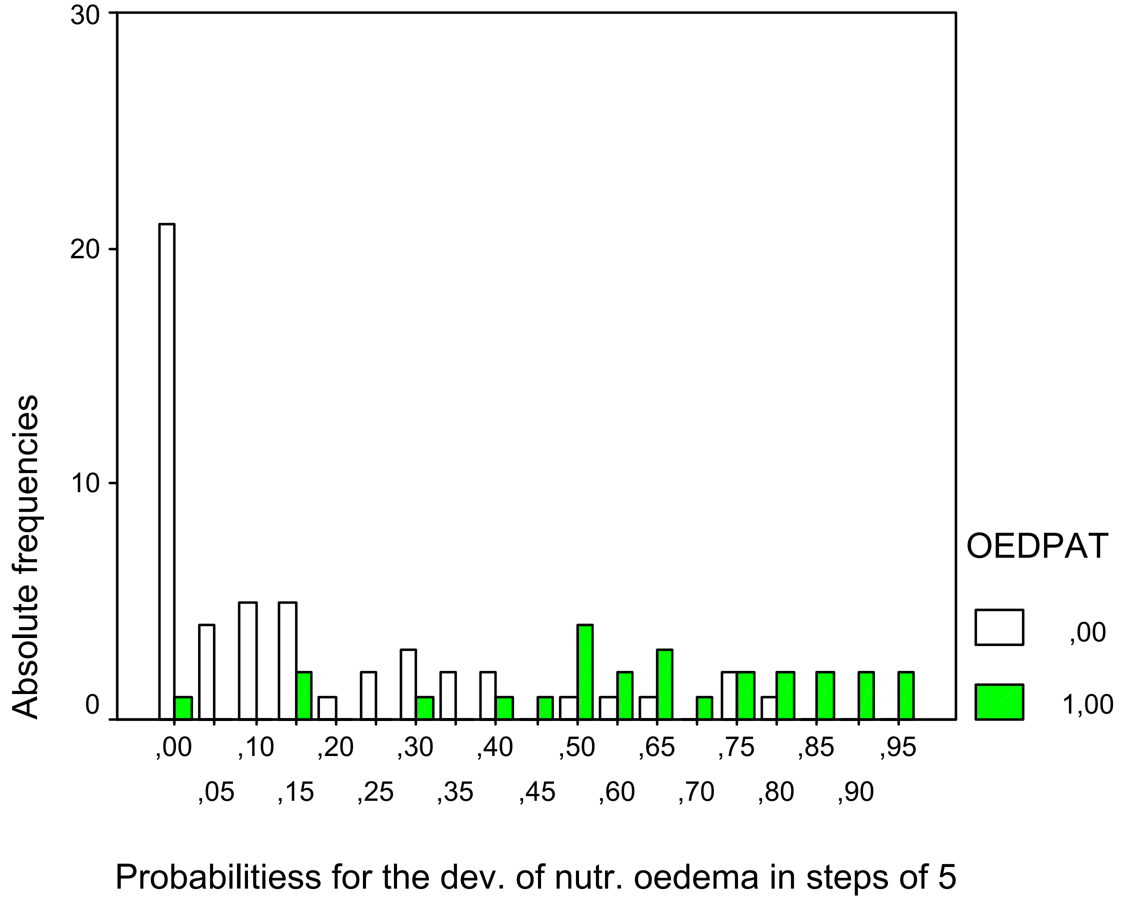

Figure 6 – 6: Probability of nutritional oedema (oedematous=1, non-oedematous =0) in the index child

With the help of these probabilities, risk classes for becoming oedematous can be formed, depending on the values of the sample.
The following risk classes for nutritional oedema were constructed:

Low risk: Below the value of p=0.15 the risk of becoming oedematous for the index child is very low (only one oedematous child).
Medium risk: For p-values from 0.15 to 0.45 a medium risk to fall ill can be supposed.
High risk: Is the p value>= 0.4 5, the risk is very high to get nutritional oedema (0.045 is the lowest p-value for which the number of oedema tous children is higher than the number of non-oedematous children.

Inserting the above mentioned values in the following logit: z [p]:= Log [p/ (1-p)]
gives following limits of the linear combination z of the risk factors :
- 1.734 and –0.20067. These limits can be used to make a prediction in the general case, if a child is in a low, medium or high risk to fall ill. To calculate the risk one includes the regression coefficients from the last logistic regression model in the above formula for z and fills in the individual values of each child for the independent variables.

In case the results are lying below -1.734 there is a very low risk for the child to fall ill. If they are lying between – 1.734 and –0.20067 there is a medium risk for the child to fall ill and if they are lying higher than 0 the risk of nutritional oedema is very high.

Policy Implications

The above-mentioned results from the logistic regression models might be useful for the application in surveys to find out the children at risk of kwashiorkor.
For this reason, the significant factors mentioned in the above logistic regression cumulative frequencies, restricted to the oedematous children, were computed.
As a limit - above which one of these factors involves only a minor risk for the development of kwashiorkor- the 92% percentile of this factor (thus excluding two cases) was applied. So, only 7.1% (2 cases) of the caregivers of oedematous children had shown a behaviour index of +2 or higher, so the limit should be set to a behaviour index of +2. In 96.4% of the households with oedematous children one or more illnesses occurred, so that only in households with no illnesses the risk of oedema was

minimal. 92.9% of the households with oedematous children had less than 11 different foods available, so the limit should be 11, thus, a variability of at least 11 food items in the household would minimize the risk for kwashiorkor to nearly zero. 92.3% of the oedematous children had a fat/energy-ratio of 11.03% or less, so that the limit should be set to 11%.

For the practical application in the field, it would be advisable to create a behaviour index which can be set up in shorter time. Since the results concerning illness occurrence in the family was an important determinant for the development of kwashiorkor, nutrition and health programs should be addressed to the entire family to minimize the risk of the occurrence of kwashiorkor in a community.

7 DISCUSSION

Nine background factors which may affect childhood nutrition were investigated, comprising agricultural production, size of the household, cash income resources and the use of it, parent's education level, nutrient intake of the children, illness background of children and household members and finally the caring capacity for the children. These were related to two different categories of clinical classification, namely children who were once admitted to the Yirga Alem Hospital classified as kwashiorkor, marasmus and controls and to the classification of the same children in oedematous and non-oedematous children after discharge from hospital. For the third classification of the sample, the post-kwashiorkor and post-marasmic children, only some investigations were conducted because of the small sample size.

Basic and underlying causes of protein-energy malnutrition

Poverty is not only manifested by low and unstable household incomes, but also by deteriorating living conditions, particularly with regards to health and access to appropriate municipal services. Poor households need income for emergency health expenditures and for long-term consumption needs such as housing. A major burden for poor families is also the education expenditures, despite the fact that the country could maintain an education system with low tuition. Households with many children have a much higher risk of becoming poor than others.

The study reveals severe household disorganisation and poverty in the PEM-households. There were obvious differences in the socio-economic background between the PEM and the control group in education, income, food expenditure, occupation and caring aspects.

Socio-economic background of the households

Maternal education has been consistently shown to be important for child health, nutrition, and survival (CALDWELL and MC DONALD 1982, ALDERMAN 1990, IFPRI 2000). Coulter (1988) reported that mothers of kwashiorkor children had a higher education than those of marasmic children. These results could not be confirmed in this study. Controversial results were reported by Thomas (1981). No impact of education on the nutritional status of the observed children could be proved. Obviously, in his study only the education of the mother was concerned. In this study an impact of the mother's education alone on the occurence of nutritional oedema could not be demonstrated. However, the education index of both the caregiver and her partner was significantly correlated with the occurence of nutritional oedema. It seems that basic education of at least one of the guardians can protect a child from getting severely malnourished. Discussions and field observations in this study show that it was important that either the father or the mother had some basic education. There were several families where the father taught the caregiver of the child some care-giving behaviour. In some of the follow-up visits we learned that the training of older siblings for some nutrition and health behaviour had a positive impact, especially when the mother or caregiver had no education and the sibling attended school.

A study in rural Bangladesh (GULDAN *et al.* 1993) examined a variety of child-feeding practices to determine which ones were associated with maternal education and whether the effect was intependent from household socioeconomic factors. Caregivers in families with education were found to feed the children more frequently, with fresher food, and in cleaner, more protected places. These and other positive behaviours suggested a shift from less attentive and frequent feeding practices to more frequent feedings in which the caregiver took more control of the child's feeding sessions when he/ she had some education. In the background of kwashiorkor the question arises if households with kwashiorkor children are poorer concerning income generation than households without kwashiorkor children. Only a few studies have recorded the monthly income of PEM-families. One of those studies made an estimation. It was concluded that controls had - compared to a PEM-group - a higher monthly income and monthly food expenditure (COULTER *et al.* 1988). In one early study an estimation of wages of fathers from kwashiorkor children was done. Nearly half of all studied fathers had monthly wages under £10 (DAVIDSON *et al.* 1965). Sive *et al.* (1993) reported that family income in both the kwashiorkor and the control group was below the household subsistence level in the vast majority of cases, but significantly more members of the kwashiorkor group claimed to have no regular cash income. Another study from Stephens (1975) reported no significant difference in wages between a kwashiorkor- and a control group. A study in Addis Ababa about kwashiorkor estimated parental monthly income. They found that 45% earned Birr 50 per month (approximately U.S.$ 24). This amount was the minimum monthly pay for government employees. (WOND-WOSSEN1983). Also in a study about children with a low rate of weight gain (KRISTIANSSON 1981) the mean income of the fathers of children with low weight gain was significantly lower compared with the other groups of higher weight gain and controls.

Coffee is an important income source in the Sidama zone. Through discussions and observations it was found that economic problems, especially in households with PEM children, has its roots in disorganisation of household resources. The small farmers with kwashiorkor children depended too much on the coffee harvest because they did not cultivate a diversity of plants on their farm. In the study year of 1997 the harvest was not good, mostly because of a coffee disease. Eventually the farmers needed a small amount of money to take home every day which they received through the sale of small amounts of coffee (three cups of coffee beans for example). They would have achieved a price three times higher if they had waited until more coffee was ready on their trees and then brought the harvest to the coffee washers. Since they sold small amounts to vendors on the market, they had an important loss of income.

In the sample of this study poverty was omnipresent - 100% of the infants came from households with incomes below the Poverty Datum Line [1]. In an earlier study Lindtjorn *et al.* (1993) found in Southern Ethiopia that socio-economic factors, such as family wealth and crowding, significantly influenced the state of nutrition among the children. In the present study, the results clearly show that not only was monetary income (absolutely as well as per capita) higher on average in the control group compared to the PEM groups, but also the stability of the income during the year was higher. As observations and discussions with families from kwashiorkor children in this study showed, the typical family relied on permanent plants such as coffee and *ensete* trees. The variability of food production in the garden was significantly less than in the control households. No efforts were made to plant different products in the garden as it was in the case in the control households. It seems that especially in households with an oedematous child farmers depended more or less on the sale of the coffee harvest, although the productivity was smaller than in the control households. In the other seasons they supplemented their income with small daily jobs. Especially the heads of household of the PEM groups were more engaged with unsociable or causual occupations. Low paid jobs, sickness, imprisonment and death

[1] Ethiopia's GNP per capita was about $110 per year in 1997 according to World Development Report 1998/99. The Country's Human Development Index (HDI), which is a composite index of income, life expectancy, and education ranks 171 out of 174 countries listed according to the Human Development Report 2000, published by the UNDP.

and desertion of a man were more common in the oedematous group than in the other group. Similar findings were discussed in a study in Ciskei/ Land (THOMAS 1981). A study carried out in India confirms the impact of the father's occupation as a risk factor for severe malnutrition (SAITO *et al.*1997). The father's occupation as a labourer (OR=2.98, p=0.005) was a significant risk factor for severe malnutrition. It was concluded that the father's occupation was a more accurate indicator for malnutrition than household income.

On the other hand, the occupation situation of the PEM groups was aggravated by having to depend upon the sole income of women for a time during the year. In the PEM groups there were more women who had to provide 100% of the household's income for some time during the year, either because the partner was not around, was unemployed, died, was ill or an alcoholic. In the post-coffee season up to 40% of the households were dependent on the sole income of the woman. Female earners in general earned much less money than male earners. Mostly they were engaged in activities where the pay was very low, such as preparing *kocho*, preparing food (*injera*; see photodocumentation), making baskets or selling some of their products like buttermilk or butter.

Although the income situation of the PEM groups was worse compared to the control group, the results reveal that higher income does not absolutely prevent the occurrence of nutritional oedema. This fact was already reported earlier. Seyoum *et al.* (1990) found that the nutritional status of children in *khat* (drug) -producing farm families (with a total cash income around three times the income of farmers who do not grow *khat*) did not appear to be better compared to that of children in other farm families. Scherbaum (1996) reported that children with kwashiorkor can also be found among more affluent families. In most of such cases the income doesn't "reach" the child. In the international literature it is known that higher income doesn't automatically prevent child malnutrition (BELLIN 1991). Assuming a simple linear relationship between household income and the prevalence of malnutrition would be misleading (ASHWORTH and DOWLER 1991). In this study it can be assumed that the decisions of how to spend available cash resources, the monetary control within the household and the allocation of resources were other important determinants for the nutritional situation of the children besides the amount of cash available. The budget share for food in the households with ex-kwashiorkor children was much lower than that of the controls and even the households with former marasmic children. This result is contrary to the findings of Coulter *et al.* (1988). In his study he suggests that kwashiorkor and marasmic children may come from different socio-economic backgrounds. Mothers of kwashiorkor children not only had a higher education than those of marasmic children but also spent more money on food.

Discussions with household members and neighbours point to social problems in the families with an oedematous child. Often the head of household used the money to meet friends in drinking places. Hence, there were financial resources but they were not used for the well-being of all household members. The decision making on how to use the cash income and monetary control was usually in the man’s hands.
Nevertheless, it also has to be borne in mind that in households with a kwashiorkor child there was a higher occurrence of illnesses in general for which medical treatment was necessary (Chapter 5.1). In addition the results show that the higher the income became the less illnesses occurred in the families during the entire study period. Thus the medical treatment for ill household members could be another important reason for the smaller budget share for food in households with a kwashiorkor child. A discussion with a father of a kwashiorkor child revealed that this child “takes away” all the money. “He would have let it die if the survey team had not taken care of it.”
Analyses in Chapter 6.1.2 demonstrate that there must be another factor beside illness occurrence and insufficiency of cash income resources. There was no positive correlation in the pre-and coffee season in terms of per capita income and foods available in the households. On the same range of income of oedematous and non-oedematous households, the oedematous households had in general 1 to 3 foods less available. Thus, people may eat more poorly than their incomes allow. One reason might be ignorance. Results from the qualitative assessment of food expenditure demonstrate clearly that the parents of oedematous children spent more money to buy basic foods already planted in their garden and that they consumed daily like *ensete*, maize and *gomen*. In this way they completed the lower quantity of the harvest of those plants (Annex A 4–5). These foods were cheap to buy at the market and especially *kocho* produced from *ensete* “fills the stomach” according to discussions with parents. Foods rich in nutrients which could have been important to com-

plete the diet - like pulses, cereals and foods rich in fat - were purchased significantly less than in the non-oedematous households. Especially for the index children depending completely on the food given in their homes, important nutrients were expected to be missing. Observations and discussions show that other household members, like older children and especially the heads of households got other foods outside their homes. Children went to neighbour's houses or to the market place to get additional food and the heads of household often bought *injera* and *wot* when they were outside the house or received some food when working on other farms etc.
As a result of the analysis of agricultural production and livestock ownership, a concentration of the plantation of *ensete*, coffee and *gomen* is evident throughout all seasons in the PEM groups, thus there was a big lack of food diversity in food production. Especially in the "hunger season" from April to July beans and roots were available in the control households beside the staple food *ensete*. Fruits such as avocado, passion fruits etc. completed the diet. Especially the households of the kwashiorkor children sold nutritional valued foods such as avocado and other fruits but also roots and beans during the year, if available.
The ownership of domestic animals, especially cows is considered as a sign of wealth of farmers (SCHERBAUM 1996). Additionally they function as a kind of "account" in times of financial needs, such as illnesses in the family, celebrations, funerals etc.. In former times, more families even possessed oxen. They slaughtered the oxen when a new house was built in order to give food to the people who helped while constructing the house. Since the population density has grown extensively over recent years in the Sidama zone the number of households possessing an oxen decreased. This is also because the land available for grazing decreased. The results in this study show that especially in households with ex-marasmic children domestic animals were not owned. Particularly the control households owned in general more domestic animals, thus the possibility to "balance" times of scarcity or financial needs was much higher. Both PEM groups on average had two cows, but it was the families from the kwashiorkor children who sold a significant part of their milk, especially during the hardest time of the year, the pre-coffee season. It was mentioned by some of them that the milk was not sufficient for all household members. Milk was especially given to the smallest children, who were still breastfed. Since most of the kwashiorkor children were not breastfed anymore, the chance to get some milk was very low. Thus, an important source of amino acids and minerals was lacking for those chil-

dren. The results confirm that especially in households in which kwashiorkor occurred the resources were not properly used. In cases where they had foods rich in nutrients for the children they sold parts of it so that in the end the children got an extremely unbalanced diet, based mainly on *ensete*, maize and *gomen*.

A lack of food diversity, including food production and food purchase, turned out to be one of the most important determinants in the development of nutritional oedema (Chapter 4.6.2).
A lack of knowledge to support the household with a higher food diversity either through planting or through purchasing, a lack of motivation to plant different foods but also selfishness or ignorance were reasons for a low food variety especially in the PEM households and this especially in the households in which kwashiorkor occurred. A study dealing with the number of food items as an indicator of nutrient intake in Japan (SHIMBO *et al.* 1994) made clear that the sufficiency rates of nutrients increased with the number of food item. Especially energy, protein and vitamin B1 had, according to the study, a significant association with the number of food items eaten each day. Daily intake of most nutrients is sufficient when 30 food items were taken. Only vitamin A intake was essentially independent of the number of food items. Food variety may be used to indicate nutritional adequacy where there is the possibility of nutrient deficiency. It was suggested that a variety score of at least 15 over one week (or greater than 12 in one day) should be considered as a minimum for nutritional adequacy (HODGON 1993). Nevertheless, it has to be taken into consideration that a food variety score developed for one culture is not the same in another, although the theory and approach for the development of the score can be used across cultures. In any sense, it is postulated that it is advantageous to eat a variety of foods to improve nutrient adequacy, dilute possible toxicants, include a wider number of non-nutrient components of food in the diet, and to take into account the physico-chemical properties of food. A greater food variety is associated with better health. To recognise improved health with increased food variety would be consistent with the evolution of the human diet. The physiological premise currently advanced for this evolution is that a loss of systematic capacity for synthesis of certain essential molecules has occurred, or that the ability to eat a wider range of foods with less dependency upon any one in particular, has allowed a greater geographical range and survival in and out of season, and from climate to climate.

The UNICEF conceptual framework suggests that a lack of care, in addition to food insecurity and a lack of health care services, is critical for children's survival, growth and development. In this study it is elicited that care plays a significant role in the development of severe PEM, especially of kwashiorkor. Whereas several studies were carried out to show the effect of care on the development of general malnutrition, rare intensive studies elicit the role of care for severe PEM, especially for the development of nutritional oedema. In this study some caring resources, behaviour and practices were registered through 24-hour-direct observations in households in which oedematous children were found.

As already mentioned by Goodall (1979) it is interesting that the statistical significances for the development of kwashiorkor are highest for the factors which touch the child's personal and emotional life most closely. Loving adults do their best to make adequate provision and appropriate presentation of food for a growing child and take an active part in feeding it to the child: poverty and ignorance may contribute to social deprivation. The investigation of the caring environment of the index children in this study reveals severe household disorganisation and extensive family disruption, with a clear distinction between the oedematous and the non-oedematous group. The results of the observations done during this study show that the huge majority of oedematous children, in addition to being food deprived, were also likely to be emotionally deprived and even neglected. Typically they did not enjoy a supportive family structure, were the product of broken homes and likely to be in the care of inept, unwilling or destitute guardians. Especially the kwashiorkor families show extensive family disruption. This was demonstrated in several previous studies (GOODALL 1979, THOMAS 1981, SCHERBAUM 1996). In this study for instance, 47% of heads of household of the oedematous compared to 28% of the non-oedematous group were either a drinker, smoker or ill. Also Carvalhaes and Benicio (1997) identified suggestive signs of alcoholism in at least one family member as a significant risk factor (OR=2.1; 95% CI, 1.2-3.9) for malnutrition. Moreover, 27% of the heads of household from the oedematous group opposed to only 12% of the non-oedematous group were absent from home at the time of the study.
One big problem mentioned by 65% of the caregivers of oedematous children compared to 33% of the non-oedematous group was the financial problem in the household which was a recurring reason for quarrels between the living partners. A lack of

male support for the family in which malnutrition occurred was already recognised earlier (KRIATIANSSON and FALLSTRÖM1981). Observations in the households of oedematous children of the current study indicated that many heads of household were not showing any responsilbilty for their child(ren).
The following family history will give an example: The head of household was living in polygamy. He had two wives, an older one with whom he had four children and a younger one with whom he had one child. The wives were living in two separate houses in one village. The head of household stayed over one night in the younger wife's house, then in the other wife's house. Both of his wives had oedematous children. He did not support his older wife with cash income. When he visited her, he left the house and took the only blanket for sleeping with him, which belonged to his older wife. The older wife lived in an extremely scattered house and finally had no blanket for herself and the four children. She took clothes to cover herself and the children at night. She asked him all the time to repair the house. The older wife finally suffered from malaria. Because they went too late for help in medical services, she died. In Sidama, people in the villages form an *idir,* a kind of social union, where all members pay a monthly rate, so that in times of sorrow this union helps the family to carry out the sorrow celebration. So, after her death, the husband got help from this union. It was finally an ironic destiny that after her death a new house was built for the husband by the help of everybody from the union to celebrate the sorrow of his wife. The resources within the household and from the society were not available when the woman was most in need.

The direct environment of the child plays an important role in the development of malnutrition and infection. According to Mata (1979) crowded homes with dirty floors, thatched roofs and cracked walls, improper bed facilities with a lack of blankets, favour transmission of respiratory and enteric agents, and proliferation of anthropods and rodents. Deficient sanitation was the most important feature of poor housing. Lack of a safe water supply, inadequate disposal of faeces and garbage, inadequate preparation and storage of food, the presence of animals in the home and deficient personal hygiene, results in large doses of pathogenic agents on hands and in food and water. Such environments may also deprive the child of psychological and social stimuli beneficial to nutrition and growth.

In this study it becomes evident that children with nutritional oedema live in such disorganised households. Observations in the houses made clear that resources available in all households to a comparable extent, such as wood or *ensete* leaves for bed construction, mud for house repairing and time etc. were used in different ways in the oedematous and non-oedematous households through their own decision. In households with oedematous children, heads of household and/or caregivers spent more time being inactive or visiting neighbours (See Chapter 4.7.3.1) instead of organising the household in a way that was beneficial to the well-being of the family and development of the child. As mentioned in Chapter 4.7.3.2 the caregivers of oedematous children did not use their time resources in a proper way to organise the household, for example they searched too late for wood for cooking, so that most of it was not dry when the cooking process started. The smoke produced stung the eyes and the children sitting around the fire to warm themselves were breathing in the smoke for several hours a day. In many cases, according to discussions, the smoke was purposely produced to make the neighbours believe that it is a rich house where much food is available for cooking.
In addition, the traditional beds, which were used in most of the houses and made out of dried *ensete* leaves, were not dried in the sun during daytime in the kwashiorkor group, so that the beds were humid and thus hotbeds for vermin. Most of the heads of household and caregivers of the oedematous group also mentioned the bad housing conditions as a major problem in their daily lives. In most cases the houses were in need of repair so they became very cold during the night-time. The danger for small children to fall ill with respiratory infections was very high in these houses. Moreover, the situation was aggravated by a common lack of blankets in those households. In cases where houses were damaged, they could have been repaired by simple methods, for example by mud etc. which is available to everyone. This example shows that available resources were not used to improve the well-being of the household.

Positive aspects of maternal practices are an emphasis on breast-feeding, adequate lactation practices, hand washing, keeping drinking water in a separate clean container, avoidance of faeces during meal preparation and eating times, adequate preservation of food, and knowledge of the need for aggressive care of the ill, particularly regarding rehydration and feeding in convalescence (LEONARDO 1979).

Through the 24–hours observations in this study the appalling hygienic situation, especially in houses with oedematous or ex-kwashiokor children, became obvious (Chapter 4.7.3.2). In the literature it is already pointed to the association between the hygienic situation and PEM (GOLDEN IN GARROW and JAMES 1993). Since it is the culture in Sidama to keep cattle in the house, the excrements of the animals were also inside the house. In most of the families the house was quite small, so that children got in direct contact with them. According to the observations done in the houses the caregivers of kwashiorkor children took less time to clean the floor. Moreover, the animals excrement was not used as an important resource for natural dung in the farm. Storage problems with the holes, where the *kocho* was stored for fermentation, was also reported. Since toilets were rarely used in all households (MÜLLER 2001), children or animals used the *kocho* silo to ease themselves, especially when it was not properly covered with *ensete* leaves (see Figure 3-4). During observations worms were often discovered at the edge of the *kocho* silo. The possible disadvantages of this for the consumption of *kocho* (toxic effects, bacteria etc.) have to be evaluated more closely. The storage of drinking water in big pots was also a problem in many households. Especially in households with oedematous children they did not clean the inside of the pot from time to time so that it was covered with dirt which was there for weeks. This behaviour bears a high risk factor for diarrhoea for the children, beside the other hygienic problems.

Caregivers did not clean cooking dishes and plates during day-time so that - when the night fell in (at about 7pm) and she started to prepare the food- it was too dark to clean the dishes properly. Mostly only one petroleum lamp was available for the whole house, so that the woman could not see whether she properly cleaned the dishes or whether they were dirty. Also hands were rarely washed before eating. The hygienic situation in the houses put children at high risk of getting diarrhoea infections. As the results from the health background of the index children show, the occurrence of diarrhoea was significantly higher in oedematous children. Moreover, discussions and observations indicate that the caregivers were searching the help of health care services too late. In the case of diarrhoea many preferred to use traditional ways of treatment such as the preparation of *ameza*, or even did nothing. It happened several times during the study period that, when somebody of the family suffered from supposed malaria, they waited too long before seeking medical treat-

ment. Because of this behaviour some of the family members as well as an index child died during the survey time.
It is apparent from the study that significantly less oedematous children were immunised compared to the non-oedematous children. This also shows that the caregivers from kwashiorkor children did not seek modern medical services to protect their children from diseases. A similar finding was already reported by Sive (1992). Only one-third of the children with kwashiorkor were appropriately immunised for their age as opposed to 80% of the controls.

The ignorant behaviour of the caregivers in the households with oedematous children was getting obvious through this study. In most cases the children were not controlled at all. Possible reasons for this behaviour are that either the caregiver was too active or too inactive.
Observations in one typical kwashiorkor house reported about a stepmother who was giving the small child some food in the morning. The child had no appetite. The caregiver did not interact with the child, also did not verbally encourage the child to finish the food. Finally the child went outside, and the caregiver was taking away the food, which was not finished. Often, the same child was found all alone in the house. The neighbours reported that nobody cared for this child. Mostly it sat sadly on the ground with nobody to talk to or to play with. In another household the oedematous child got for breakfast porridge to eat. All household members were leaving the house. The older children went outside, either to school or to the market. The mother and grandmother went to work in a separate small house beside the living house to distil and sell alcohol. Some hours later the mother came back to the house. She checked the child’s bowl. When she registered that there was something left, she replaced the bowl with the rest of the food in front of the child without re-heating it and without motivating the child to eat. After some minutes she left the house again for work. Finally, since the child did not eat it, a chicken started to eat the porridge. It was mentioned already by Engle *et al.* (1997) that very young infants of women from poor households, who are engaged in time-intensive production activities, who have little control over income allocation and who do not have good alternate caregivers, are at risk of low growth. The above-described case was an extreme example of a feeding situation where supervision of feeding was not adequate. Other siblings or even animals, as described in this case, may take advantage of a young child’s vulnerability and

take food away, or food may be spilled on the ground (ENGLE *et al.*1997). The older siblings who were supposed to stay with the child left to go to the market and the mother did not spend time with the child to ask it to eat or to prepare something different. According to Leichsenring (1999b, personal memorandum) a typical kwashiorkor child ignores food and also denies feeding attempts. Then, an active feeding behaviour is absolutely necessary. Bentley *et al.* (2002) reported that responsive feeding behaviours may include active physical help and verbalisation during feeding, role-playing, persistence, and positive feeding strategies. In their study positive caregiver behaviours were significantly associated with higher child acceptance of food, while non-responsive feeding behaviours were associated with child rejection of food. Growth performance of children is positively correlated with maternal attitudes (various beliefs and practices concerning infant feeding and, tangiently, medical care). Socio-economic status, as an indicator of the family's financial ability to provide food and medical care, did not account for variation of nutritional status (DETTWYLER 1986). Passive feeding may be due to lack of time and energy or to beliefs that children should not be pressured to eat- that "the stomach knows its limits" (BENTLEY *et al.* 1995). An experience of the author of this study with a kwashiorkor child in Rwanda, gives an example of a lack of self-confidence of the mother and demonstrates that feeding behaviours may be as important as food availability for child nutrition (LONGHURST and TOMKINS 1995). When the child, a boy of 9 years of age, was suffering from malaria, he asked his mother only to give him cooked bananas, because he had no appetite for other foods, such as beans etc. Bananas are mainly composed of carbohydrates. The mother did what he wanted. For several weeks she only gave him this food without changing anything in his diet. He was eventually admitted to hospital with kwashiorkor. What Griffith (1988) already pointed out is, when poor appetite or anorexia of the child is a problem, caregivers need to actively encourage food consumption. This means having the time, knowledge, resources, self-confidence and support to encourage anorexic children to eat.

The care giving capacity may also be influenced by the ill health status of the primary caregiver of the child. Winkvist (1995) reported that poor health and nutrition status of caregivers are likely to limit their ability to provide adequate care in many countries. Direct evidence from this was shown in Egypt, where poor dietary intake, low haemoglobin levels, and low vitamin B6 status of the mothers were related to less time spent on care, less response to infants' vocalisation, less vocalisation to infants, and greater utilisation of older siblings as caregivers. Data from a study in Kenya (McDONALD *et al.* 1994) shows that during a temporary food shortage (a famine), mothers held and cared for their children significantly less than before the shortage. The higher need to procure food resulted in increased child care by siblings and other family members. Also in Kenya, illness among women forced them to reallocate a number of tasks, including child care, to other family members (NEUMANN and SIGMAN 1992). A study in Barbados (GALLER 1999) identified psychosocial variables affecting early infant feeding practices. Disadvantaged environmental conditions, including less information-seeking by the mother, lower family income, and poor maternal health, were closely associated with increased symptoms of depression and anxiety in all women. Some of the caregivers in this study were handicapped by sickness or mental abnormality and showed a grossly disturbed relationship with their children. Also the reason for stopping breastfeeding gives a hint that many caregivers of the index children were ill and finally stopped giving the breast to the child, or she separated from the father or even died. The caring capacity was also diminished when the head of household or even other household members were ill. One mother told the survey staff, that she was taking care only of the head of household while he was ill and not for the small child which finally fell ill from kwashiorkor. The man in his role as a principal earner has a special status in the family. When he is ill the family must live without income. Moreover nobody works on the farm. Thus, his recovery has to be the main priority. The mother admitted that in this time she did not care enough for the small child which developed kwashiorkor.

The behaviour of the caregiver towards the index child turned out to be one of the most important determinants in the development of kwashiorkor. A young and/or sick child is highly dependent upon the caregiver's beliefs and attitudes for the development of good health and nutritional status. If a caregiver is ignorant of the nutrition of the child, doesn't look and control a young child while eating, doesn't give enough emotional support for the child and doesn't take measures for the hygiene of the child, the chance for it to develop in a good manner decreases tremendously. An unwilling, inept or ill caregiver cannot support the development of a child in a proper way. Deprivation of loving emotional support also can influence the treatment of kwashiorkor in a negative way (VIRDIS 1994). It was noticed in this study that chil-

dren with kwashiorkor who were looked after by their mother had a better recovery than orphans and those cared for by siblings or relatives.
Positive patterns of interaction between caregiver and child and a nurturing home environment are significantly associated with later cognitive development of children in a variety of cultural and ethnic groups (BRADLEY and CALDWELL 1984; BRADLEY *et al.* 1989).
A similar association between kwashiorkor and such determinants as poor mothering, separation of mother and child, and lack of parental support has also been reported in earlier studies (MORLEY *et al.* 1968, GEBER and DEAN 1956, THOMAS 1981).

It became obvious through this study that care plays a significant role in the development of nutritional oedema. Whereas 90% of the control children were getting good care according to the classification done in this study, 95% of the ex-kwashiorkor children were getting medium or bad care. According to the results in this study only good care protects from nutritional oedema.

The study also shows the relationship between care and the adequacy rate of nutrient intake. The better the care was, the better the fulfilment of the requirement of the main nutrients, energy, fat and protein. Children who got only medium or bad care were over represented in the lowest classes of adequacy concerning the main nutrients (Chapter 6.1.4). This result as well as the result of the final logistic regression analysis points to the important role of care in the development of PEM- especially of kwashiorkor. Concerning hypothesis 1, through this analysis it gets clear that especially kwashiorkor children were exposed to more psycho-social factors of stress, which might also help to increase radicals leading to oxidative stress. Moreover, if the personal care of a caregiver of ordinary competence, a stable relationship between the parents and the support of the father constitute the minimum requirements for family life, it could be concluded that hypothesis 3 is true. Most oedematous children were growing up in a non-supportive family structure and could not have expected adequate care.

Immediate causes of protein-energy malnutrition

Both immediate causes of PEM - food consumption and communicable disease - affect nutritional status in a way of a “malnutrition-infection complex”. It is known that the relationship between malnutrition, infection and immune response is cyclical, with changes in one in turn influencing the other two (KEUSCH 1990). Malnutrition may be initiated by primary or secondary dietary deficiency (e.g. mal-absorptive states), or by the metabolic effects of infection. The consequence is impairment of host defences, which in turn leads to an increased burden of infection and further malnutrition. The onset of infection initiates a number of physiological and metabolic changes that alter host nutritional status. In healthy individuals losses in nutritional status are replaced during convalescence.

Diseases

Infection belongs beside nutritional intake to the immediate causes of kwashiorkor. It is one of the major factors contributing to the increased morbidity and mortality associated with PEM (SUSKIND 1990). Kenneth *et al.* (1981) reported that 90% of children admitted with severe protein-energy malnutrition had some evidence of systemic infection: 49% of patients had pneumonia, 43% percent of admissions had diarrhoea and 40% had evidence of enteric infections, most commonly Shigellae or rotavirus.

Infection often precedes the development of kwashiorkor (OYELAMI 1995). Morley (1978) reported that measles precedes the development of kwashiorkor in about 25% of cases. Another study reported that kwashiorkor is known to be precipitated by illnesses such as measles, gastro-enteritis, malaria, pneumonia and bronchitis (WHITEHEAD and COWARD 1971). In Nigeria (OYELAMI *et al.* 1995) they found that recurrent diarrhoea is associated with its development in about two-thirds of cases and pneumonia is a common feature in the remaining one third.

In the first study of our project, in which all children admitted to Yirga Alem Hospital with severe PEM were investigated for their illness background before admission, 70% were admitted with diarrhoea, 38% had conjunctivitis, 27% had cough, 14% suffered from otitis media, 10% had xerophthalmia and 18% had an irritable behaviour (MÜLLER 2001).

As results and discussions with parents of the kwashiorkor children of this study show, the development of kwashiorkor seems to follow a certain “symptom pattern”. First, the children start to loose appetite. Poor appetite is also mentioned earlier to

play a major role in inadequate nutrient intake of children (PIWOZ *et al.* 1994; BANTLEY *et al.* 1995). Factors that reduce a child's appetite may include a monotonous diet. One older kwashiorkor child reported, that the mother only prepared *kocho* made out of *ensete* for him every day, combined with *gomen*. He "did not like to eat this kind of food anymore and totally lost his appetite". Another result from a discussion with an older kwashiorkor child tells that the child lost, during an episode of malaria, his appetite for any other food than bananas, a food item composed mainly out of carbohydrate but somehow sweet in its taste. Other factors that reduce appetite are a lack of nutrients needed for developing appetite (for example zinc), illnesses such as fever (NEUMANN *et al.* 1994), diarrhoea, malaria, measles, intestinal parasites, chronic malnutrition, sores in the mouth (perhaps caused by teething) or anxiety (DETTWYLER 1986, 1987). A study, carried out in a Peruvian village (BENTLEY *et al.* 1991), reported that in response to reductions in child appetite during illness mothers are more likely to encourage children to eat, while they tend to become more passive feeders after the diarrhoea has stopped.
In many of the households with former or actual kwashiorkor children it was recognised through home visits that parents of kwashiorkor children did not take the time to sit and eat with the children. Through negligence the appetite also decreased.The loss of appetite is reported to be either accompanied or followed by abdominal cramps. Most of the parents of oedematous children in this study reported that the children got abdominal cramps before the occurrence of oedema. Since this symptom is not commonly described in the literature more investigations are necessary to find the reason for this symptom. Abdominal cramps are often described as a symptom of gastro-intestinal infection with parasites. Ascariasis for example, was directly implicated in causing a deterioration in nutritional status (CROMPTON *et al.* 1985), and Gardiasis is well recognised as being an important cause of malabsorption syndrome (FARTHING 1988). The burden of intestinal worms is known to be widespread in Ethiopia. A study in west Wollega (SCHERBAUM 1985) demonstrated, that the vast majority of severely malnourished children had infections with one or more different species of helminths. Although the relation between helminthic infections and nutrition is complex (MEAKINS *et al.* 1981), the causal relation between intestinal nematode infections and malnutrition is not clearly proved (KLOETZEI *et al.* 1982). Nevertheless, the effect of ascariasis on digestion and absorption of dietary proteins (VENKATACHALAM 1976) as well as the role of hypoproteinemia associated with

hookworm infections (FASWARAN *et al.* 1982) are probable to trigger malnutrition. Abdominal pain is also mentioned as one early feature of niacin deficiency besides stomatitis, anorexia, weakness and irritability. Prolonged niacin deficiency results in gastro-intestinal symptoms such as vomiting and diarrhoea (PRENDIVILLE and MANFREDI 1992), which were, as mentioned above, all present in kwashiorkor children. Besides the above mentioned possible reasons for abdominal cramps also the change in the gastrointestinal tract of the index children as an accompanying symptom of kwashiorkor must be borne in mind. As supposed by Diwany (year not mentioned) iron deficiency and folic acid deficiency and maybe other dietary insufficiencies (especially protein) can lead to changes in the epithelial pattern of cells lining the gastrointestinal tract. During the home visits it was reported by the parents of PEM children that especially in the pre-harvest time from April to July, when the families had a lower income, they were preparing more or less only *kocho*. During this time the *kocho* is not fermented enough and contains a lot of water. When children were eating this kind of *kocho* they often had stomach pain afterwards.

Finally, after suffering from abdominal cramps, diarrhoea starts. One of the major sources of unusual free radical loads to the body is gastrointestinal infection (JACKSON *et al.* 1990). In the background of the development of nutritional oedema the results of this study make clear that diarrhoea had an important impact on the disease. The investigation of the occurence of diseases in the 14 days previous to the last home visit even show that all 8 children who were suffering at the time of the visit from nutritional oedema also suffered diarrhoea in the 14 previous days from. The findings of a high occurrence of diarrhoea are similar to findings elsewhere (MCLAREN *et al.* 1965, WHARTON *et al.* 1968, COULTER *et al.* 1988, SIVE 1993). Risk factors for the occurrence of diarrhoea as declared already in other studies (ZEITLIN *et al.* 1995) have been especially found in the kwashiorkor families: faecal contamination and garbage disposal in infant's outdoor play compound, crawling, contact of hand and mouth with contaminated materials, greater distance of household from water source, inadequate cleaning after defecation, dirt on child's face, presence of flies, feeding rotten food; insufficient washing of infant's and caregiver's hands before feeding and lack of caregiver's willingness to visit a modern health practitioner. A bacterial overgrowth in the small intestine is reported in kwashiorkor cases (JAMES 1977; GRACEY 1981). It had been shown in some former studies that

the food given to young children is heavily contaminated with faecal and pathogenic micro-organisms (BARRELL and ROWLAND, 1979, HIBBERT and GOLDEN, 1981). During the current study some samples of left-over food, which were given to the children the following morning, were given to a laboratory for examination of faecal micro-organisms in Yirga Alem Hospital after the home visit. In each of the samples a high contamination of the food could be found. According to Jackson (1990), chronic diarrhoea, which is associated with severe gastrointestinal dysfunction, may lead to increased losses of total nitrogen, fat, fat soluble vitamins and trace elements in faeces. Thus, for example losses of zinc and copper in diarrhoeal fluid (CASTILLO-DURAN *et al.* 1988) probably make an important contribution to the promotion of a deficiency state. The losses of specific nutrients may create the potential for more chronic problems associated with nutrient imbalance. The model of zinc deficiency as a consequence and cause of diarrhoea is a good example (JACKSON 1990). It was further noted that one effect of zinc deficiency in malnourished children is to impair the normal metabolic handling of vitamin A.
Not only diarrhoea seems to be a risk factor for the occurrence of kwashiorkor. Also poor nutritional status resulted according to Yoon (1997) in a 1.6-fold increased risk of diarrhoeal mortality for each one-unit decrease in weight-for-age Z score. The diarrhoea – malnutrition circle is well known and it is often difficult to know which one of the two is playing the initiating or the dominant role (STANFIELD 1966).

In most cases, when diarrhoea stops, the child gets oedema. Diarrhoea, abdominal cramps, loss of appetite and often vomiting were found to be risk factors for the occurrence of nutritional oedema in this study, especially in the pre-harvest season, in which the food availability was smaller. They occurred significantly more often in oedematous children. Besides the above-mentioned symptoms of kwashiorkor, the oedematous children were significantly more often exposed to diseases but not to any specific one during the one-year study period. Moreover it was found that the risk of becoming oedematous was higher, if the number of diseases the child was exposed to increased (Chapter 5.1.2.3). Also the additional investigation of disease occurrence in the post-kwashiorkor and post-marasmic children shows that during the investigated seasons as well as throughout the year there were more post-kwashiorkor than post-marasmic children suffering from at least one disease.

As reported by Mata (1979), infectious disease frequently resulted in marked reduction in energy consumption, equivalent to an average of 200Kcal/d. Food loss due to anorexia and fever were estimated as 4% and 2% respectively. Finally, it turned out that food losses due to infection were 8%.
The nutrient intake of the children, demonstrated in Chapter 5.2.2.2.2, show that obviously the deficits caused by the frequency of infection were not being appropriately corrected during the study period. Therefore the risk for a constant morbidity is very high. But also the unhealthy environment as described in Chapter: 4.7.3.2 especially of the family houses where kwashiorkor occurred, helps to increase the probability to infectious diseases for the entire family. Humid, leaking and unclean houses with a lack of night blankets were the typical “picture” of a family house where nutritional oedema occurred. The results of this study also show that in the households where a child became oedematous the other household members were more often exposed to any kinds of illnesses. As it was demonstrated in Chapter 4.6.2, the food variety was very low in the households with an oedematous child but also in the ex-kwashiorkor households. Thus, it can be supposed that also siblings and adults living in these houses had a lower immuno-competence because of their unbalanced diet. Unless some household members were provided with foods richer in nutrients or obtained food outside the home, the diet will not be adequate for the health of the family. On the other hand, as some examples from this study show, if somebody in the family was ill, (like the father) the time-, care-, and food -resources were given to the ill person. The child, apart from having an unbalanced diet, is more neglected, so that kwashiorkor can easily develop.

Through the results of this study it could be demonstrated that the oedematous children were exposed to increased stress, either psycho-social stress caused through a lack of care or through increased infective episodes. Thus, concerning hypothesis A1, it can be concluded that especially kwashiorkor children were more exposed to noxae that generate oxidative stress than control or even marasmic children were.

Under usual conditions, oxidative reactions are instantly neutralized by endogenous antioxidant systems (enzymes, free radical scavengers, metal chelators) whose bioactivity is largely dependent on dietary intakes (ALBRECHT and PELISSIER 1995). The remaining question now is how efficient their defence mechanisms are to with-stand the stress. There are a number of protective pathways against these free radicals, which require micronutrients (vitamins, zinc, selenium etc.) (MANSON-BAHR 1991), and also sulphur-containing amino acids for their efficient function. A deficiency of any of these micronutrients etc. will lead to a loss of protection, resulting in cellular damage giving rise to the oedema, fatty liver, pigmentary changes, diarrhoea, immunoincompetence and mental changes typical for kwashiorkor (GOLDEN 1987). The questions will be discussed in the next section.

Nutrition

In 1933 Dr. C. Williams described the whole picture of kwashiorkor. In her study she reported that maize was the only source of supplementary food and she supposed that some amino-acids - or protein deficiency cannot be excluded as a cause of kwashiorkor. Moreover she pointed to a lack of vitamins A, C, D or E. A deficiency of some part of the vitamin B complex also was not excluded (WILLIAMS 1940).

Nevertheless, up to now, surprisingly few extensive analyses with respect to nutritional intake of kwashiorkor or marasmic children have been described in the literature. According to Church (1979) this is not surprising, because childhood weighed-food-intake studies are difficult and especially so under conditions which predispose to malnutrition.

Since it is reported that kwashiorkor mostly occurs in the weaning age and that marasmus often happens earlier (during the breastfeeding period**) feeding habits concerning breastfeeding and weaning** have to be taken into account when discussing the reasons for the development of severe PEM. The results from this study demonstrate the importance of the weaning pattern, described by the period of breastfeeding and by the time of introducing other foods (apart from breast milk) and its quality, in the development of severe PEM.

Coulter *et al.* (1988) reported that the **duration of breastfeeding** was significantly longer for controls (up to 17 months of age) compared to PEM- groups (marasmus group: 13 months, marasmic kwashiorkor and kwashiorkor groups up to 14 months). The differences within the PEM groups were not significant.

In this study it could also be demonstrated that the control children on average got breast milk for a longer time (median: 25.5 months) especially when compared to marasmic children (kwashiorkor: median 24.0 months, marasmus, median: 12 months). The marasmic children were breastfed for the shortest duration, thus other foods were introduced earlier. As Knutsson (1969) reported in an early study in

Sidama, the duration of breastfeeding in this zone was shorter than in other sites of Ethiopia. 32% of the children were breast-fed for 19 months or more, and 38% for 7 to 12 months. Only two infants were given breast milk for less than 7 months and in both these cases breastfeeding was stopped because of disease, in one case of the mother and in the other of the infant. Therefore the marasmic children of this study were more represented in the formerly reported breastfeeding habits of Sidama women. Nevertheless, the results from this study show that a prolonged time of breastfeeding seems to give a certain protection for developing nutritional marasmus. Although there has been some controversy about the consequence of prolonged - thus a duration longer than 12 months-, breastfeeding (VICTORIA *et al.* 1984; BRAKOHIAPA 1988) on the nutritional status, Cousens *et al.* (1993) in a case-control study found no association between prolonged breastfeeding and increased risk of clinical malnutrition in Burkina Faso. Briend and Bari (1989) pointed to the fact that breastfeeding beyond one year does not seem to be effective in reducing malnutrition, but the risk of dying was six times higher in non-breastfed malnourished children than in similarly malnourished breastfed children (PRENTICE 1991).

Taking a closer look at the duration of breastfeeding it was found that none of the control children of this study stopped being breastfed before the age of 8 months, whereas about 10% of the children from the ex-PEM groups were already weaned at this time. In the marasmus group more than 50% of the children did not get breast-milk anymore before 19 months, compared to about 40% in the kwashiorkor group and only 15% in the control group. Looking for the reasons for this phenomenon, the data showed that other reasons for stopping breastfeeding, beside a new pregnancy, played a more important role in the development of severe PEM, and especially for the development of marasmus. More often it was reported by the mothers from marasmic children that they were sick, or the child refused the milk or because of social reasons, in this case the separation of the parents.

Apart from the period of breastfeeding also the **initiation of other liquids and foods** beside breast milk as an important part of the weaning pattern gives some important hints for the development of severe PEM. Data from this study shows that it is a common habit in Sidama to reject colostrum. Research results have shown that colostrum has the demonstrated ability to kill bacteria and viral invaders, stimulate tissue repair (particularly the bowel lining), stimulate fat utilisation for fuel and optimize cellular reproduction (anti-aging) (CNR 2002). In this study more than 60% of mothers from all groups were not giving colostrum. Often the colostrum is considered to be dirty and to cause stomach pain in the child. This was also reported from other parts of Ethiopia (SCHERBAUM 1996). Especially in the PEM-groups mothers tended to give water and/or herbal teas to their child. In Sidama the women often introduce the herbal drink *ameza*, as described above. It is used as a kind of common medicine against many diseases, and has the meaning of a “kind of immunisation”. More than three quarters of mothers of PEM children used herbal teas for their children in the first 4 months. In the control group this habit was much less common. Also the custom to introduce water to the child was significantly different in the investigated groups. Half of all mothers from marasmic children interviewed gave water to the child during the first months of life. In the kwashiorkor group it was reported in about one third of cases and in the control group up to about 14 %. Therefore, the number of mothers who were exclusively breastfeeding their child were at a minimum. Exclusive breastfeeding means that the baby has no other food or drink but breast milk (SAVAGE KING and BURGESS 1992). In countries in the south it is especially important to exclusively breastfeed the child. Introducing other fluids beside breast milk can cause infections, especially diarrhoea. Often the cycle of diarrhoea and malnutrition starts at that moment. As the results show in this study, diarrhoea turned out to be a significant determinant in the development of kwashiokror.

Not exclusively breastfeeding a child bears another significant danger for the child, the transmission of the HIV virus. Latest experiences show that exclusively breastfed infants were less likely to be infected with the HIV virus at three months than were those receiving mixed feeding or those never breastfed (COUTSOUDIS 1999). In Ethiopia, HIV/AIDS is a significant problem. According to a recent report (REUTERS 2000) over 3 million people in Ethiopia have HIV, which is 9.3 percent of the country's sexually active population. Not counted are the unknown cases. Since children are mostly not tested for the virus in hospital, it is unknown whether children admitted at hospital for severe malnutrition, TB or other severe illnesses might in addition have the HIV virus or suffer from AIDS. Especially some of the marasmic children were supposed to suffer from AIDS when, after re-feeding in hospital, the health and nutritional status of the children were not improving significantly.

The weaning pattern is described also by the time of **introducing other foods** (apart from breast milk) and the quality of the food. Formerly it was reported that early weaning and its causes lie at the root of the problem of malnutrition (MC LAREN

1966). The data of the on hand study shows that not only it was a habit to give other fluids beside breast milk early to the child, also other foods than the above mentioned fluids were introduced to a much higher extent by the caregivers of PEM children during the first 4 months than by the caregivers of the control group (25% in the PEM group and 14% in the control group, respectively). Also the other extreme, the very late introduction of other foods, was reported, especially by the caregivers of kwashiorkor children (17% in the kwashiorkor group and 10% in the marasmic and control group). The data also makes clear that the beginning of malnutrition was caused by the quality of weaning food. The weaning food introduced to the PEM children of this study was significantly worse than that introduced to the control children. Mostly maize porridge was given to the children without notable diversification during the whole time of weaning. As also demonstrated in the food expenditure pattern, the caregivers of PEM children prefered to buy foods which were cheap and already planted on the farm: maize and *ensete*. Other cereals (e.g. wheat, *teff*) beside maize with a higher nutritional value were purchased to a much lesser extent than by the controls. Moreover, it was reported by caregivers of PEM children that they gave *kocho*, the common food for adults made out of *ensete*, to the children while weaning. As Müller (2001) reported in the parallel study of the project, *kocho* was mentioned as a food to avoid giving to a child while weaning. The reality showed indeed that nearly 20% of the caregivers gave this food to their child, mostly because no other foods were available. This result was also reflected in the food diversity available in the families of the sample. Potatoes or other root vegeatbles, which are very suitable for the preparation of weaning food were given less by the caregivers of kwashiorkor children (14% of kwashiorkor, 22% of marasmic and 30% of control children, respectively). Other cereals or vegetables did not play a significant role in the preparation of weaning food. Animal products, such as eggs and milk were also given significantly less often to the PEM children during weaning compared to the control children.

Milk plays an important role in the weaning food, especially when the quality of the weaning food is composed more or less out of maize. The data highlighted that especially in households in which kwashiorkor occurred, milk was rarely given to the child. Mostly it was consumed in the form of buttermilk, but from the food measuring it was learned that in those households the buttermilk was diluted to a high part with unboiled water. Moreover those families sold the biggest part of the buttermilk they had, because it was supposed that the quantity was not sufficient for the entire family. Moreover it was an income source for women, especially when the husbanddid not give enough money to the wife. This was another example for a resource available in the household but not used for the sake of the child.

Meat did not play a role in the weaning food of any children. Especially for the children not receiving breast milk anymore, a lack of important nutrients will be the result. In the study by Coulter (1988) foods from animals were playing a more significant role in the diet of children, also of PEM children. It was reported that other milks (goats', cows' or artificial) were offered (mean months of age) earliest in controls (5.2), latest in kwashiorkor (6.8), and intermediate in the marasmic (5.9) groups. A mixed diet was introduced earliest in controls (4.5) and at approximately 5.4 months in the PEM children. The most obvious difference in specific foods between the groups in his study was meat, which was offered daily as follows: in 49% of kwashiorkor children, in 36.1% of marasmic children and in 75.6% of control children.

One part of interest in the study was the question whether there is evidence that **protein** is limited in the diet of the oedematous children. In the background of the development of kwashiorkor the protein intake has to be analysed along with the **energy intake**. It has been learned in the past that if the total food intake is inadequate, a secondary protein deficiency will result, because protein cannot be utilised if energy is lacking (WATERLOW 1975). The results of the present study show that for the oedematous children the lowest energy intake took place before and after the coffee-harvest time, thus over a time period of about 8 months, up to 40% below the recommended level. The analysis for the post-kwashiorkor and -marasmic children demonstrates that the post-kwashiorkor children had a sufficient energy supply only in the coffee-season, in the side-harvest seasons the energy supply was falling with the lowest intake being in the post coffee harvest time. In comparison, the post-marasmic children had a too low supply of energy throughout the year which was also between 10% and 20% lower than the energy intake of kwashiorkor children. Only in the post-coffee season was the intake 10% higher than that of the post-kwashiorkor children. The results are comparable with the results of an earlier study in Uganda (COWARD and WHITEHEAD 1972). It was observed that in the 2nd and 3rd year of life of children living in an environment where kwashiorkor is common, energy intakes were frequently 70% or less of the recommended levels (approximately 100Kcal/kg for children 1-3 years). Baby baboons fed the starchy staple food of the Baganda tribe in Uganda developed all the features of the syndrome of kwashiorkor.

In a former study by Waterlow (1975) it was pointed out that one difference between kwashiorkor and marasmic children is undeniable: children with kwashiorkor must have been less energy deficient than those with marasmus, for the reason that their bodies contain more fat, as is apparently at autopsy. On the other hand Gopalan (1968), who carried out a prospective study of children in a poor community in India, developed the term "dysadaptation". He found no quantitative or qualitative differences in the diet of the children who developed kwashiorkor and those who became marasmic. He therefore suggested that it is not the diet that determines the clinical picture, but the way in which the subject adapts or fails to adapt.
According to Mc Laren (1974), marasmus results from grossly restricted intake of all nutrients and energy. Bhattacharyya (1975) reported that the difference between the dietary deficiency leading to the development of typical kwashiorkor and that producing typical nutritional marasmus, when apparent, is quantitative and not a qualitative. The diet in both groups was deficient in energy, protein and other nutrients. The calories contributed by proteins were of similar proportion (about 10 percent) and both suffered from protein malnutrition as well as energy undernutrition. The nitrogen balance data indicated protein malnutrition to be more severe in marasmus than in kwashiorkor. He also reported that for the kwashiorkor children the breastfeeding period was longer. Waterlow and Rutishauser (1974) reviewed the existing dietary data until this time from six countries and found that energy intakes were strikingly low and protein intakes were low only secondarily. Only in Thailand was dietary protein intake below the estimated requirement level. Church (1979) concluded that if children had been able to eat enough of the same food to cover their energy needs their protein requirements would have been met. Rutishauser and Frood (1973) hinted at the bulkiness and low energy density of traditional Ugandan low-fat weaning diets as factors contributing to low energy intakes of children in the weaning period. Even giving the food *ad libitum* for an experimental period the children failed to achieve recommended intakes. Similar results were reported by Binns (1975) with sweet potato as main component for the weaning food for children in Papua New Guinea. Frequent episodes of poor appetite further reduced the intake of children getting a traditional weaning diet with low energy concentration (RUTISHAUSER 1974). The maize pap with which children with kwashiorkor had been fed for several months before the appearance of acute symptoms provided almost 7% of the energy as protein, but only 290Kcal/kg. To satisfy energy requirements, it would have been necessary for a 2- to

3 year-old-child, to consume 4.5 kg of the maize pap each day (NAISMITH 1973). It is concluded that protein deficiency, which leads to the development of kwashiorkor in the Sid community, arises from a very severe restriction in energy intake rather than from the consumption of foods very low in protein at adequate or excessive levels of energy intake.

The oedematous children in the current study had - beside the very low energy intake- over a long time of the year a deficient intake of **protein** in the pre- and post coffee season and had a marginal supply of protein in the coffee season. The post-kwashiorkor children had a too low protein intake for about 8 months. Therefore, there was especially an energy deficiency over a long time of the year aggravated by a seasonal too low protein intake. It has to be borne in mind that parts of the protein were used for energy as a result of the lack of energy supply. Especially milk was missing in the diet of the children. During the weaning period kwashiorkor children received significantly less often milk other than breast milk compared to the controls. Similar findings were reported from PEM children in Colombia. Less than half of the children with PEM were receiving no milk at all. (WRAY and AGUIRRE 1969). Also in an early article published by Moodie (1965) he reported a poor milk intake especially in older children. While 69% of those under 9 months were being given about 1 pint milk per day, only 16% of the older children were getting this amount.

In addition to the intake of energy and protein separately, the P/E ration provides a good way of looking at the adequacy of protein intakes. It was reported (GOLDEN 1982) that the diets of children in areas where kwashiorkor occurs generally contain above 7% protein-energy. Therefore it was concluded that factors other than plasma proteins are of prime importance in oedema genesis. In this study it has to be taken into consideration that only about 82% of the ingested protein is digestable in this diet. In the pre- and post coffee season, about 50% of oedematous children had a P/E ratio below the P/E cut-off point of 5% compared to about 30% of the non-oedematous group. The investigation of the post-kwashiorkor and -marasmic children gave an even clearer picture. More than 80 % of the post-kwashiorkor children in the pre-harvest season had a P/E ratio below the cut-off point compared to about 30% of children in the post-marasmus group. Also in the post-coffee season about 60% of the post-kwashiorkor children had a P/E ratio below the cut-off point and throughout all seasons the ratio was smaller for the post-kwashiorkor than the post-marasmic patients. Nevertheless, the *mean* P/E ratio was lower than the recommended cut-off point only in the pre-harvest season.

In the analysis of the adequacy of the diet of the children it has to be taken into consideration, that there was a quite high prevalence of infections, especially diarrhoea. Having this in mind, there should be an extra requirement for catch-up during the days that the child is not ill. The impact of infection would require an increase in energy intake of about 7% and an increase in protein of about 15% (WATERLOW 1994). The data of this study show that it was nearly impossible for the children to fulfil this requirement.

The most striking feature in the analysis of nutritional intake was the extreme low **intake of nutritional fat**, which for all children was far below the recommendations. Especially for the ex-PEM children the intake was tremendously low. For the oedematous children the low fat/ energy-ratio turned out to be one of the most important determinants of the development of kwashiorkor. More than 80% of the oedematous children were grossly deficient in fat throughout the year (Chapter 5.2.2.2.2). In the pre-and post coffee season the oedematous children received only about 20% of their needs. The main part of the fat intake was derived from the main food items *ensete* and *gomen*. The fat intake of the non-oedematous group was also much too low, but about twice as high as the intake of the oedematous children in these two seasons. In contrary to the diet of the oedematous children, a higher extent of the fat intake for the non-oedematous children was derived from vegetable oil. A comparison of the fat adequacy ratio between the post-kwashiorkor and -marasmic children demonstrated that both groups were grossly deficient in fat supply with the post-kwashiorkor children, as was also observed for the protein intake, having had a better supply in the coffee-season but an even lower supply in the side-harvest seasons. It is assumed that a diet should never contain less than 10 percent of calories from fat (KING and BURGESS 1992). A risk analysis for the development of kwashiorkor peformed in this study goes conform to this recommendation. It is advised that the limit should be set to 11%, because 92.3% of the oedematous children had a fat/energy-ratio of 11.03% or less. The respective data for the oedematous children was below 10 percent throughout all seasons, with the lowest fat-energy ratio in the pre-coffee season (6%).

With respect to the low fat intake in former studies in kwashiorkor some degree of steatorrhea has been observed (JELLIFFE 1956). In Southern India (MEHTA *et al.*

1956) it was reported that in kwashiorkor patients on a low fat diet the faecal fat exceeds even the fat intake. It was suggested that part of the fat in stool is of endogenous origin. Demaeyer and Vanderborght (1958) supposed that two factors are responsible for the steatorrhea observed in kwashiorkor: faulty digestion, due to diminished enzyme production, and a defective absorption, which might be caused by “a biochemical lesion of the intestinal wall.” A much too low fat intake can cause a wider range of negative consequences on the nutritional situation of a young child. Fat supplies not only essential fatty acids but also helps to absorb fat- soluble vitamins A, D, E and K. It is substrate for the production of hormones and mediators. Fat, especially in infancy and early childhood, is essential for neurological development and brain function (MILNER 1999). Even though the intake of vitamin A, E, K and D was not analysed in this study, a marginal or grossly deficient status of these vitamins could be expected, resulting from the extremely low fat intake. In a former study by Selinus *et al.* (1971), it was reported that the intake of vitamin A of toddlers between 6 months and 3 years of age was unsatisfactory, being 65% of the adequacy figures. Thus the presumptions from Williams, as mentioned above, are true, since fat intake was extremely low. Also the quality of fat has to be considered when discussing the fat intake and its possible impact on the development of kwashiorkor. Evidence of essential fatty acid (EFA) deficiency was obtained from the children with kwashiorkor (NAISMITH 1973). Since breast milk is rich in linoleic- acid it is discounted as a factor in the development of EFA deficiency, but the weaning foods were found to provide substantially less than the minimum recommended intake of 1% of the total energy as linoleic acid. In a study about malnutrition (SALIMPOUR *et al.* 1982) it was suggested that essential fatty acid deficiency is to be expected as the result of long starvation and diarrhoea in severely malnourished children. Leichsenring *et al.* (1995) also reported in kwashiorkor children lower levels of linoleic acid metabolites and docosahexaenoic acid than in marasmic children. He suggested that the kwashiorkor syndrome is associated with impaired desaturation and elongation of polyunsaturated fatty acids (PUFA), possibly resulting by disturbances in hepatic metabolism of PUFA or deficiencies of other nutrients, e.g. zinc, (JEFFCOAT *et al.* 1984). Also an increased lipid peroxidation may account for the reduction of PUFA (LEICHSENRING *et al.* 1995).

Since the contribution of protein and especially fat to the total energy was low for the kwashiorkor children in the current study, the contribution of **carbohydrates** to the total energy was extremely high. The differences were also significant between the post-kwashiorkor and the post-marasmus group. A diet composed predominantly of carbohydrates was also reported before, but not to the extent as it was measured in this study. In Uganda it was reported that children from 1 to 3-years-old living in an environment where kwashiorkor is common, 85% of the calories were derived from carbohydrates (RUTISHAUSER 1972). The dominant role of the starchy food item *ensete* was shown in a former dietary study from the Sidama zone. The contribution of carbohydrates to total energy is reported to be 90% in the diet for the children above 3 years of age and adults and 75% for toddlers (younger than 3 years of age). When carbohydrate consumption levels are at or above 75% of total energy there could be significant adverse effects on nutritional status by the exclusion of adequate quantities of protein, fat and other essential nutrients. (FAO 1997). In a recent study about maternal energy and macronutrient insecurity in an *ensete*-corn staple village in the Sidama zone (TAFFESSE *et al.* 1988) a high contribution of carbohydrates to the energy intake (88% of the total daily energy was provided by carbohydrates) was reported, so that in general the composition of the diet in this zone might be supposed to be unbalanced especially for women and small children.

Young children consuming marginally sufficient calories are at risk **of micronutrient** (MESSER 1997) and **vitamin deficiencies**. Children may be inadequately fed and malnourished even when ingesting apparently adequate food energy. Apparently adequate intakes of staple foods may mask restricted access to relatively more expensive animal products, fruits, and treats of higher nutrient density. According to Leitzmann and Bellin (1992) especially the access and consumption of foods rich in nutrients is a preferred strategy for the prevention of diseases related to nutrition.

Golden (1982) pointed out that protein is unimportant in childhood nutrition and supposed that only some factor other than protein gives rise to the oedema of kwashiorkor. These other factors are assumed to be **antioxidants**. Several vitamins and micronutrients are functioning as antioxidants, such as vitamins A, C and E, zinc, selenium, some carotenoids, flavonoids, and polyphenolic compounds. Several B Vitamins are also involved in the antioxidant system (Figure 7 - 1).

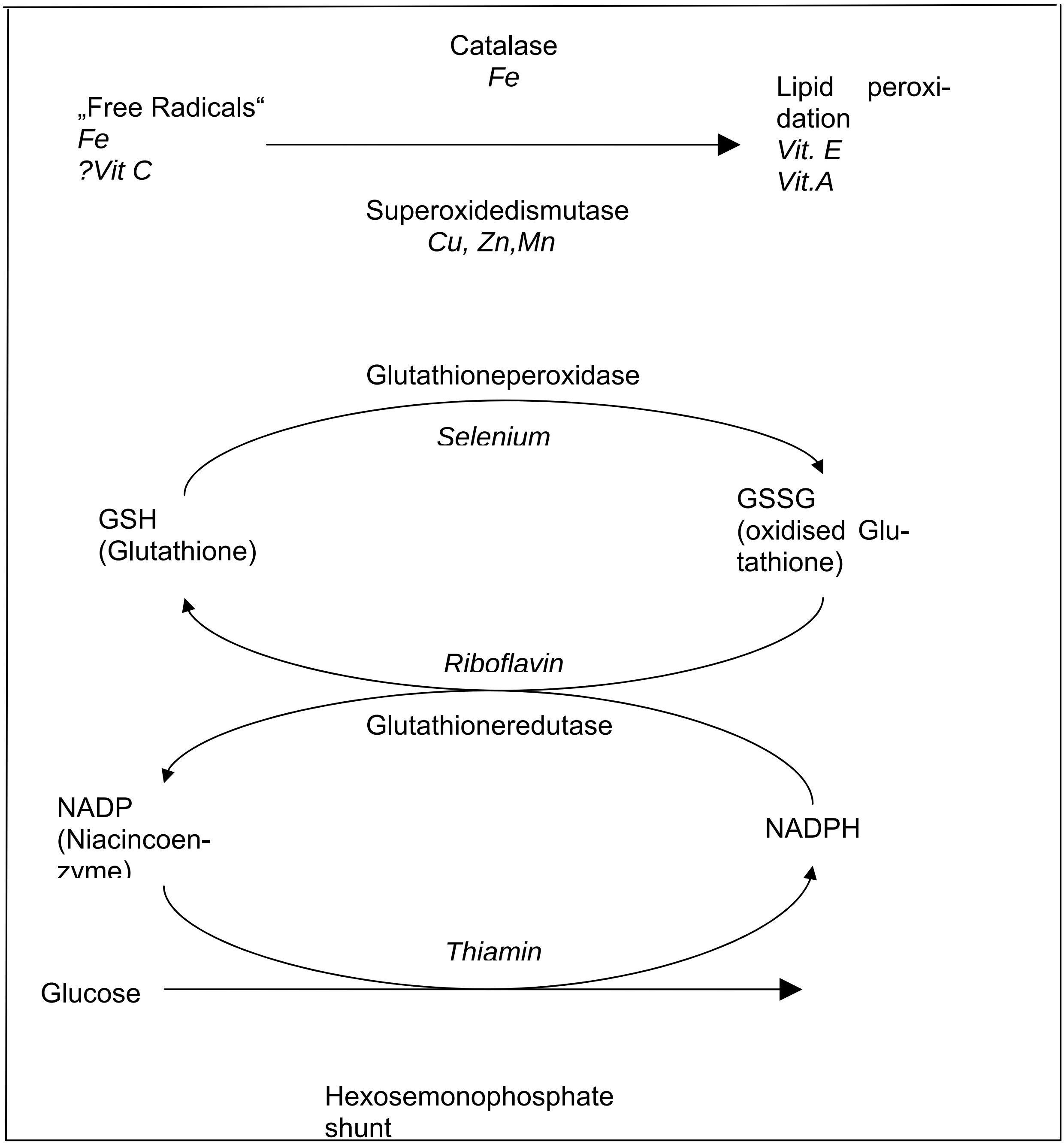

Figure 7 – 1 : The cyclical oxidation and reduction of glutathione (GSH) is central to the mechanisms whereby the cell protects itself from the potential damaging effects of free radicals. The processes associated with the protection from the adverse effects of free radicals involve many specific nutrients that have been found to be deficient in severe malnutrition.
Source: JACKSON in HARRISON and WATERLOW 1990, p.105

In this context Golden (1987) posed the question whether the levels of antioxidants are low in kwashiorkor because of an increased rate of consumption by dissipation of radicals or whether they are low because of an inadequate dietary intake.

Concerning the intake of vitamins and micro-nutrients, the **deficiency of B vitamins** was especially observed in kwashiorkor children, as the data confirmed when the sample was classified at hospital admission, according to the classification of oedematous and non-oedematous children after discharge from hospital as well as in the small sample of children who developed kwashiorkor or marasmus after discharge from hospital. The adequacy data as well as the classification in three adequacy groups demonstrates that especially the kwashiorkor children had a deficiency in all B-Vitamins investigated. Many more oedematous children were grossly deficient as compared to non-oedematous children. Post-kwashiorkor children had an especially low intake of **thiamine (p=0.044) and niacin**. Not even 50% of the recommended intake for both vitamins was fulfilled (measured by the median) throughout the year of investigation. Previously (HAILEMARIAM *et al.* 1985) it was suggested that **thiamine deficiency** might play a role in the background of PEM. In a Jamaican study 30% of the children showed evidence of thiamine deficiency on admission to hospital. Unrefined and enriched cereals, organ meats, meat, legumes, and nuts are good sources of thiamine (BROWN 1990). None of them were found regularly in the diet of the oedematous children (especially documented for the post-kwashiorkor children). Because meat plays a minor role in the diet of all children, cereals and legumes which are available in this region, would have been necessary to include in the diet. These foods were clearly more often consumed by the control children. Moreover, the oedematous children in general consumed coffee, either prepared from the coffee beans or from the leaves. But coffee contains thiaminases which may additionally contribute to thiamine deficiency. An extreme deficit of thiamine may result in a disease called “Beriberi” (BROWN 1990), which causes damage to the nervous and cardiovascular systems. Beriberi is particularly devastating in infants. Symptoms include cyanosis, tachycardia and soundless crying. In a study by Tainsh (1984) it has been suggested that the oedema of beriberi, which was not observed with experimental thiamin deficiency (EIJKMAN 1929), requires the added stress of mycotoxicosis to produce oedema.

Niacin is widely available in food, particularly in animal products, cereals, legumes and seeds. Milk, green leafy vegetables, and fish as well as coffee and tea also contain this vitamin (JACOB and SWENDSEID in BROWN 1990) and it may be synthesised from tryptophan in the human body (PRENDIVILLE and MANFREDI 1992).

Deficiency of niacin results in pellagra. The classic features of pellagra are dermatitis, diarrhoea, and dementia, but the entire symptom complex is not commonly seen in the early stages of the disease. Early features of the disease include glossitis, stomatitis, anorexia, weakness, irritability, abdominal pain, depression, apathy and forgetfulness. Prolonged niacin deficiency results in gastro-intestinal symptoms such as vomiting and diarrhoea. Neuropsychiatric symptoms are associated with demyelination of the posterior and lateral columns. As the dietary data demonstrate, the intake of niacin was especially low in the PEM- children. The post-kwashiorkor children were even more affected because the deficiency was lasting over a long period over the whole year. In the pre-harvest time they fulfilled on average only 47% of the recommended intake, in the post-harvest time not even 40%. The post-marasmic children were mostly concerned in the pre-harvest time, where the intake was similarily low as it was for the post-kwashiorkor children. But finally, the adequacy ratio was increasing to nearly 60% (mean) for the rest of the year, thus they were not in the extreme situation (having an intake of up to about 40% (mean) of the recommendations) like the post-kwashiorkor children. According to this background it has to be borne in mind that symptoms of kwashiorkor, such as soundless crying, weakness, anorexia and abdominal cramps, vomiting and diarrhoea could also be symptoms of vitamin B deficiencies. Also neuropsychiatric symptoms, such as gnashing the teeth has often been observed by health personelle in the Yirga Alem Hospital when children were admitted with kwashiorkor. Beside the decreased niacin intake the tryptophan intake also seemed to be, according to the estimations of special amino acid intake, reduced, especially for the oedematous children. Therefore, the synthesis of niacin from tryptophan in the human body might also be lower in the illness group.

The PEM- children also had a lower intake of **riboflavin** compared to control children. Riboflavin is important for energy production, enzyme function, and normal fatty acid and amino acid synthesis and is necessary for the reproduction of glutathione, a free radical scavenger. Riboflavin deficiency is usually associated with other vitamin B complex deficiencies, an isolated deficiency is rare. An important consideration in the workup to riboflavin deficiency is that it can result from a reduction in serum proteins. The appearance of the symptoms of riboflavin deficiency does not necessarily imply a reduced food supply. Because riboflavin is transported in the bloodstream as a flavin-protein complex, nonavailability of the carrier protein also leads to apparent riboflavin deficiency (TSIOURIS and ZIEL 2002). Riboflavin is involved in regenerating glutathione, one of the main cellular protectors against free-radical damage (MURRAY 1996). A former study about concomitants of kwashiorkor-dermatosis had already mentioned that typical symptoms of riboflavin deficiency such as cheilosis, angular stomatitis, glossitits, blepharitis and perineal dermatitis were observed in 65% of the classical kwashiorkor children as compared to 24% to 29% in the other cases (BHATTACHARYYA 1972). Powers *et al.* (1983) reported profound riboflavin deficiency in infants in the Gambia.

Riboflavin was in abundance in the diet of the non-oedematous children in this study in the coffee harvest time and post-harvest time resulting from a higher consumption of cereals, pulses, but especially milk. This result goes along with the result of a survey carried out by the ENI (1980), where it was found that the riboflavin intake was excessive in Sidama. Unsatisfactory was the intake of the oedematous children. They met only about 70% (median) of their requirement on average. Also for post-kwashiorkor children as well as for post-marasmic children the riboflavin intake was only about 80% (median) throughout the year. Differences in these two groups were found concerning the different season. Since the diet of the kwashiorkor children improved in general in the coffee-harvest time, the intake of animal foods increased (median of riboflavin intake was about 95%), whereas the post-marasmic children did not have a significant improvement of the intake during the year.

Riboflavin is widely available in protein-rich foods such as milk, cheese, meat, eggs, and with moderate amounts in dark- green vegetables, whole grain products and avocados. Also dried peas and beans, available also in Sidama, have some riboflavin (TSIOURIS and ZIEL 2002). Only *gomen* is regularly eaten by the children, therefore it is a good source of riboflavin. A deficient intake of riboflavin is associated with changes in oral mucous membranes, eyes, skin, and genitalia. Conjunctivitis and photophobia may occur (PRENDIVILLE and MANFREDI 1992). In comparison to the B vitamins thiamine and niacine, riboflavin intake was quite high corresponding to a marginal intake. Becker *et al.* (1995) unexpectedly found, by an analysis of the glutathione and associated antioxidant system, a normal erythrocyte FAD, an index of the riboflavin status, in most malnourished patients. It was assumed therefore, that the high concentrations are unlikely to indicate an adequate riboflavin intake, rather they might reflect muscular wasting. Riboflavin released from muscle tissue can normalise the FAD status of other cells including erythrocytes.

With relation to the sample of the current study a deficient intake of riboflavin for the post-kwashiorkor children was measured in the pre-coffee harvest time, whereas during the rest of the year the intake was marginal. Therefore, it would also depend on which time of the year a blood sample is drawn.

The above-mentioned deficiency for B-vitamins plays a significant role in the pathways directly responsible for averting the potential damage that free radical generation may cause. One factor which has been found to approach an absolute distinction between oedematous malnutrition (kwashiorkor and marasmic kwashiorkor) and the wasting syndrome marasmus is the blood level of **glutathione** (GOLDEN and RAMDATH 1987, JACKSON 1986b, MAYATEPEK *et al.* 1993, BECKER *et al.* 1995). Glutathione is the central component in the body's defence mechanism against a wide range of noxious agents. It is a tripeptide formed from three non-essential amino acids, glutamic acid, cysteine and glycine. Glutathione peroxidase, a seleno-enzyme, is found to have a particularly low level of activity in kwashiorkor children who have died (BENNETT *et al.* 1983). To maintain the cellular level of glutathione in an effective reduced state requires interaction with cofactors and metabolites whose activity depends upon a range of specific minerals and vitamins (JACKSON 1986b). Exactly those vitamins were marginally deficient or deficient in the diet of kwashiorkor children especially. As Figure 7-1 demonstrates, thiamine, niacin and riboflavin are involved in the process of cyclical oxidation and reduction of glutathione. Thiamine deficiency impairs NADPH (niacin coenzyme) production and so, if there is a concomitant increased flux of radicals, GSH would become depleted.

Apart from thiamine, considerations of the other nutrients involved in free radical protection and their place in the glutathione metabolism may explain both why there are some clinical similarities between deficiencies of these nutrients and the features of kwashiorkor, and why experimental removal of these nutrients results in the production of individual signs of kwashiorkor when the deficiency is extreme (GOLDEN 1987).

But also, as indicated by the Figure 7-1, fat soluble vitamins A and E play an important role in this process. Their absence is common in undernutrition, particularly in those with oedema (WHO/UNICEF/USAID 1982, CHARLEY *et al.* 1985). The importance of Vitamin E as a chain-breaking antioxidant has been stressed before

(INGOLD *et al.* 1987). In an earlier study (DIWANY *et al.* 1965) it was reported that serum **vitamin E** levels were low in kwashiorkor children. Leichsenring *et al.* (1992a) found a Vitamin E deficiency through a low plasmatocopherol/lipid ratio of <0.5mg/g compared to marasmic and control children which all had a ratio of >0.7mg tocopherol/g lipid. Becker *et al.* (1994) reported a strong deficiency in α-tocopherol, total tocopherols, and total tocopherol/total lipid ratio was lower in kwashiorkor children than in controls. The tocopherol/lipid ratio was also significantly lower when compared with marasmic children. An insufficient vitamin E status was reported to have an important bearing to the megaloblastic anemia of kwashiorkor. In addition it may contribute to increased oxidative stress in kwashiorkor, as proposed by Golden (1985).

The effects of vitamin E on immunity are closely linked to the presence or absence of other antioxidants, particularly selenium (CHANDRA 1983) and ascorbate (Packer *et al.* 1979, WEFERS and SIES 1988) or glutathione (BECKER *et al.* 1994). The content of vitamin E, zinc and selenium in the diet of the oedematous and especially post-kwashiorkor children must be assumed to be very low. Although the exact intake of these antioxidants has not been calculated through the data of food weighing, the data from the food frequencies as well as from the weighing give some important hints to this assumption. Foods with a high content of vitamin E in Southern Ethiopia are especially vegetable oils and avocados. Both were consumed seldom and in a low amount by the ex-PEM children. Moreover the intake of fat, which is important for the absorption of fat soluble vitamins, was significantly too low in the diet of PEM children. Comparing oedematous with non-oedematous children it becomes clear from the data of the food frequency that the non-oedematous children had more often consumed vegetable oil as well as avocado throughout all seasons. Comparing post-kwashiorkor with post-marasmic children, the post kwashiorkor children had consumed oil more often compared to the post-marasmic children throughout all seasons. But in the post-coffee harvest time the marasmic children more often consumed avocado with the same frequency as oil consumption compared to the kwashiorkor children. Thus, a higher intake of Vitamin E by the marasmic children might be assumed only in this season.

Zinc deficiencies have been associated with a lowered resistance to infection, thymic atrophy with depression of the local cutaneous delayed hypersensitivity reaction and may produce skin ulceration and diarrhoea (JACKSON 1986). There is evidence that

a large proportion of malnourished children have some degree of zinc deficiency (GOLDEN, GOLDEN and BENNETT 1985).This is likely to be particularly true for children with oedematous malnutrition (GOLDEN *et al.* 1985). The effects of zinc deficiency on human growth were first described in Iran and Egypt (PRASAD *et al.*1963, PRASAD *et al.* 1972, RONAGHY *et al.* 1974, HALSTEAD *et al.* 1972). In these locations zinc deficiency was associated with high phytate, high fiber and low protein diets and with hookworm and schistosomiasis (HALSTEAD *et al.* 1972), situations which may also have created other micronutrient deficiencies.
The zinc supply of the oedematous children compared to the non-oedematous children must be considerably lower. Foods available in Sidama that are good sources of zinc are: whole grain cereals, legumes, meat and poultry. As demonstrated by the food frequency data all those foods were less often or even never consumed by the oedematous children compared to the non-oedematous ones. A difference in the intake of zinc must be expected also when kwashiorkor and marasmic children are compared. Resulting from the food frequency data, the post-marasmic children consumed cereals, especially maize, (to a very small amount also wheat) but also legumes such as red kidney beans and beans more often than the post-kwashiorkor children. Especially in the post-coffee season their intake of cereals and legumes was higher. In this context it has to be borne in mind that zinc deficiency can be a consequence and cause of diarrhoea (JACKSON 1986), which is a common feature in kwashiorkor.
Good sources of **selenium** in Sidama are cabbage, onions, whole grains and nuts. All of these foods were clearly consumed more often by the non-oedematous children, with exception of *gomen* that was consumed daily by nearly all children. For the distinction between kwashiorkor and marasmic children no big differences in the diet were observed. Kwashiorkor children consumed onions more often, whereas marasmic children ate more whole grains. Therefore, only through an analysis by food weighing or by drawing a blood sample more detailed information can be gathered.
Vitamin C intake was low for the PEM children but the marasmic children had the lowest intake of Vitamin C throughout the year.

The **sulphur-containing amino acids**, particularly cysteine and methionine are the main nutritional derivatives of glutathione for defence against free radicals (HUXTABLE 1986). They are needed to initiate protein synthesis, growth through poliamine synthesis, and provision of glutathione and ingested cyanogens, agents proposed to be meaningful in the pathogenesis of kwashiorkor (GOLDEN and RAMDATH 1987, KAMALU 1993). Sulphur amino acids are the most important suppliers of anionic sulphur or sulphate anions for processes of sulphitation, first that of keratin in skin (DEBERSAQUES and ROTHMAN 1962) and of hair bulbs (LEBLOND *et al.* 1957). Since the sulphur content of skin in infants is twice as high in the first 4 years of life than in later childhood or adulthood, the vulnerability of methionine deficiency would be highest during those years (KLAUDER and BROWN 1936).

In the background of the development of kwashiorkor a deficient intake of sulphur amino acids, the main component of glutathione, is assumed (GOLDEN and RAMDATH1987, BECKER *et al.* 1995, LEICHSENRING 1995). A deficiency of sulphur amino acid intakes has been documented in rural Kenya (SIMMONS and BOHDAL 1970; BEATON *et al.* 1992), where kwashiorkor occurs. Staple food analyses from countries where kwashiorkor occurs have shown that cassava, sago, rice, and yam are limited for nitrogen utilization because of low levels of methionine (MILLER and DONOSO 1963). The amino acid content of roots and tubers, unlike most cereals, is not complemented by that of legumes as both are limiting in respect of the sulphur amino acids. In order to maximise their protein contribution to the diet, roots and tubers should be supplemented with a wide variety of other foods, including cereals (FAO, 1990).

Ensete, the main staple food in the Sidama zone and the main food received especially by kwashiorkor children also belongs to roots. According to the nutrition composition tables, the content of sulphur amino acids is very low compared to other foods. Although in this study the adequacy rate of amino acids containing sulphur could not be reliable, the data give an important hint that children with nutritional oedema had a lower intake compared to non-oedematous children. Moreover the variable turned out to be one of the most important determinants for the development of nutritional oedema.

The data also show that oedematous children did not eat comparitively often whole grain and pulses, important sources of antioxidants. Pulses, which are available and used in the Sidama zone contain tocopherols, flavonoids and isoflavonoids, all of which can act as antioxidants. The isoflavone content has been shown to increase two to three times after germination. Thus both dry legumes and green and germinated pulses are good sources of antioxidants. Moreover pulses contain about 3.5

mg of Vitamin E per 100 g as compared to 1.2 mg in cereals. The flavonoids are reported to have four to five-fold antioxidant activity as compared to ascorbic acid. Although pulses may not be a major source of antioxidants, they can contribute significantly to the total daily intake of antioxidants from the diet (NARASINGA RAO 2002). On the other hand, it was shown by Golden (1987) that there was sufficient cysteine, glycine, glutamine and energy in a blood examination of malnourished children.

Beside the sulphur-containing amino acids, which are in the focus of discussion about the reduced capacity of kwashiorkor children to defend against free radicals, the nutritional data of amino acid intake indicates a generally lower intake of all amino acids investigated in the study by the oedematous children when compared to the non-oedematous ones. The absolute difference of the intake between the two investigated groups was especially high for leucine. Leucine has been credited with exerting a specific control on protein turnover in muscles (JACKSON and GRIMBLE 1990). As mentioned by Roediger (1995), depletion of leucine in kwashiorkor leads to a chain of events whereby muscle protein accretion is reversed and glutamine released to maintain integrity of the small intestine and immune system. With diminished availability of glutamine, intestinal and immune functions would be compromised. This would contribute one explanation to the higher occurrence of disease in kwashiorkor, especially diarrhoea.

An abnormal plasma amino-acid pattern in which certain essential amino acids, such as the branched chain group, threonine, lysine and tyrosine, are disproportionally low in concentration was reported by Whitehead and Dean (1964) in Uganda. The results from the absolute intake of amino acids on hand study point to the fact that the deficiency of these amino acids might be caused by the diet of the children. The intake of lysine and also threonine was considerably lower in the oedematous children. In the context of the development of kwashiorkor it has to be borne in mind that there is an interdependence of the two essential amino acids lysine and methionine. Lysine is generally required for ribosomal elongation of many proteins, including hair growth. It is also needed for carnitine synthesis and histone formation (DEVLIN 1992). Both processes require methylation from methionine (ROEDIGER 1995).

Threonine is required for formation of collagen, helps prevent fatty deposits in the liver, aids in production of antibodies and can be converted to glycine (a neurotransmitter) in the central nervous system. Moreover it acts as a detoxifier and is needed by the gastrointestinal tract for normal functioning. Symptoms of deficiency are rarely seen. They are skin disorders and weakness. Food sources for threonine are dairy, beef, poultry, eggs, beans, nuts and seeds (http://www.anyvitamins.com, accessed 2004). All these foods were rarely (beans) or even never consumed by the oedematous children.

Besides the intake of macro- and micro nutrients in the diet of the index children in this study the nutritional inhibitors in the diet, which might considerably reduce the availability of some nutrients, have also to be taken into account. Especially the role of phytate has to be considered in a diet mainly consisting of root plants. Phytate is a storage form of phosphorus which is found in plant seeds and in many roots and tubers (DIPAK and MUKHERJEE 1986). Phytic acid has the potential to bind calcium, zinc, iron and other minerals, thereby reducing their availability in the body (DAVIS and OLPIN 1979, O'DELL and SAVAGE 1960). In addition, complex formation of phytic acid with proteins may inhibit the enzymatic digestion of the protein (SINGH and KRIKORIAN 1982). Thus processing into fermented foods reduces the phytate level of root crops sufficiently to nullify its adverse effect.
According to discussions and observations in the current study it was reported that kwashiorkor children often consumed the more fibrous part of the *kocho*. Moreover it was reported that especially in the pre-harvest time between April and July kwashiorkor children consumed a *kocho* which was not fermented enough. Mostly then the children complained about stomach pain. It can be suggested that the phytate content in this *kocho* was quite high, so that the negative effect on protein and mineral absorption could have taken over.

It was apparent from this study that especially the kwashiorkor child was exposed to a high level of stress. In general the disease is initiated by a difficult situation in the household where the child lives resulting in deprivation of loving emotional support, because the caregiver is someone other than the mother or is ignorant of childcare. In additional the high occurrence of illnesses of other household members - who might also have higher priorities- but also of the child itself helps to aggravate the situation. Since the scarce resources available were not used by the households in a way to improve daily life, the threat to the child's life greatly increased. In the examined households food for the young child was scarce or non-existent or unused due

to ignorance. A lack of care, knowledge or self-confidence leads to an incorrect feeding behaviour, which finally leads to a deterioration of the nutritional status of the child. The study demonstrated that considerable chronic and seasonal macro and micro –nutrient insecurity exists, which results in a breakdown of the antioxidant system in kwashiorkor. The seasonal deficiency of the ex-PEM children, oedematous or post-PEM children respectively was tremendous. The composition of the diet with an extremely high proportion of the energy intake from carbohydrate and at the same time a low proportion from protein and fat was not consistent with what is recommended for optimal growth and long term good health. In cases in which the diet is composed more or less of one or two different foods and this/those foods consisting mainly out of carbohydrates, kwashiorkor will be the end result.
The study demonstrates that the quality of protein is substandard with a very low animal protein intake as well as cereal or pulses protein. Especially oedematous children suffered for a time period of 8 months from these deficiencies. The families depended too heavily on the coffee harvest. Therefore the nutrient intake was better for the kwashiorkor children during this time. Marginal to grossly low intakes of macro- and micro nutrients carry functional consequences including less energy availability for discretionary activities, greater vulnerability to illnesses and lower growth.
Complementing the dominant *ensete* diet with increased animal products, cereals, leguminous crops, fruits and vegetables in a more consistent rather than seasonal fashion would be worthwhile to eliminate the likely harmful nutritional consequences.

The results of the study show that the interaction of social and biological factors in disease causation were mostly apparent in the discussion about PEM and especially in the background of kwashiorkor. At the cellular level the problem is clearly biological. It is obvious by the results of this study that normal metabolism, the antioxidant system and growth cannot be maintained since the variety of nutrients were not given in sufficient quantities. But as soon as it is taken into consideration how to transfer all the important nutrients it becomes clear that social and cultural factors, especially resource exploitation and the role of care for the child, were strongly involved in the causation of the disease.

8 A TYPICAL HOUSEHOLD WITH A KWASHIORKOR CHILD IN SIDAMA,- A REFLECTION OF OBSERVATIONS AND DISCUSSIONS DURING HOME VISITS

During the study period it was observed, that some characteristics of the households were found in nearly all households in which kwashiorkor occurs. The survey team finally summarised those characteristics in a short list: Subsequently some examples are listed in excursus.

- Available resources are not used in a proper way to secure daily life of the family:

  - They have farmland, but they do not use their land resources in a way to ensure daily life, compared to control families. The head of household does not farm, therefore no diversification in agricultural cultivation is found, although the soils in Sidama are fertile. The people don't try new things, hold on to old believes and cultures (*ensete* cultivation with coffee without diversification). Since they depend only on coffee grown in the garden, they have to sell a small amount during harvest time each day. They can sell these amounts only at vendors and not at the coffee washer places. In the study time the price for one kilo of red cherish coffee was 3.50 Birr, but at the market they got only 1 Birr for one kilo. Through this an important amount of money is lost. They lack knowledge of how to use the garden in the right way. The challenge is to make them <u>believe</u> that diversification is good for the family.

  - There is a problem with the collection of wood, the main energy source for cooking. Apart from a common wood scarcity in Sidama, the family members in those households do not store the wood in the house. They start to search for wood shortly before meal preparation starts. Often then the wood is too wet, so it takes a long time to start a fire for cooking and therefore a lot of smoke is produced in the house. This is often done on purpose, because they want to make the neighbours believe that something is being cooked in the house. Others mentioned that the smoke tides the roof and warms the house.

The concentrated smoke might pose a health problem for anyone being inside the house for a prolonged period of time.

- The families live in bad housing conditions: the house is damaged, half part open, so that rain comes in. During the night-time it is very cold. In most cases the house is humid. No efforts are made to repair the house by simple methods (using mud or *ensete* leaves to close the holes in the house, repairing the roof etc). In many cases there is also a lack of blankets or clothes so that the danger of getting ill is quite high.

- Very poor hygienic conditions: no latrine is built, the place to urinate is often beside the ensete fermentation silo; this silo also is not properly covered, children are not washed, especially not their hands before meal. The plates and cooking facilities are not cleaned after meals. There is a permanent lack of water in the houses. The water fetched is mostly only used for drinking and cooking, but not for personal hygiene or for cleaning dishes etc. In some families the children were not cleaned for months.

- The caregiver prepares the same food every day: kocho made out of the ensete plant, without any change in the diet. Mostly, the quantity of kocho is higher than that of gomen. In most cases the child likes to eat the gomen first, and eats the cold kocho later. The child's diet is highly unbalanced. An example of a typical meal for a kwashiorkor child is given in Annex C. Some of the control women mentioned to avoid kocho and gomen as a food for small children, because it makes a "thick belly".

- If they have food resources available they sell them. In the case of butter milk, it was especially observed in the households in which kwashiorkor occurred, that it was diluted with water. The butter made from the process to prepare butter milk is used for cosmetic purposes.

- Time resources are not used in an appropriate way. The caregiver prepares food very late. Moreover they take a long time to finish food preparation because in between they run out of the house to do something else like talking to the neighbours. The children stay for hours without food and cry. When the food is prepared, they are often too tired or not hungry any more. Often then the child cannot finish the food, so that it gets the left overs, mostly *kocho*, the next morning, without being re-heated.

- The caregiver has priorities other than taking care of the child; she uses much time either to go to neighbours, where they talk and drink coffee, or uses the time for income generation. Time resources are once more not used in an appropriate way. The end result is that there is no control over the child. The child is often sitting alone at home for hours.

- Economically the money earned within the family doesn't reach the child or is not used in the right way to ensure a healthy life for the child. The cash money available to the caregiver is used to buy the same food items, which are already available in the garden. Not all persons in the household are supporting the household. The heads of household often do not give enough money to the wife to buy some food. Often they keep parts of their income to spend on alcohol or other items such as clothes, shoes for themselves or to buy prepared food in restaurants.

  The older siblings do not help the caregiver, they are outside the house the whole day and only come home to eat. They get additional food outside the home, whereas the kwashiorkor child only receives food prepared by the caregiver.

- The responsible persons in the household don't think and plan for the future. In the coffee season, when more cash income is available, they buy other things such as clothes, sometimes a radio and better food. They use the money at once without keeping savings for the time after the harvest. Later they often sell the things bought before for a much lower price to buy food. Another example is the woman being the only responsible person in the household. She doesn't make sure that new ensete trees are planted in time for the future years. Moreover, in most households old coffee plants are not replaced by new ones.

- In families with a kwashiorkor child there is often a personal problem between caregiver and head of household.

- The caregiver or head of household is not contributing work and care to the household since he/she is not present (in prison, in another region, in hospital etc.) or is present but ill.

- There is a high disease occurrence in the families with the head of household having absolute priority for receiving care when he is ill. Illnesses mean a financial burden to the household. Most of them also use the health facilities only when it is already too late.

- The child is exposed to a high level of stress either through illnesses, through toxins (for example smoke) or psychosocial stress through a lack of care. At the same time, no resistance against the stress can be built because of the highly unbalanced diet he/she receives.

Excursus:

Some examples of family situations in a household with a kwashiorkor child:

One family surveyed by the research team was quite a rich family, had farmland and even a cow. The head of household was working as a "Kabale chairman" (district chairman), thus had a well paid and secure job. In a follow -up visit the former patient as well as the younger sibling had oedema. The mother did not follow the advice given by the study team in a former follow-up. She was very inactive concerning her caring duties for the small children. On the day of the home visit for example she was preparing lunch for the children at 5 p.m., since she went to a wedding and to church without the children. Finally she prepared some kocho and gomen. The children only ate the gomen, and later they started to eat the cold kocho, which she did not re-heat. The father affirmed every time that they don't have a food problem in the house.

Another mother of a former kwashiorkor child discussed her problems with one of the study team members. The mother complained that the father of the children did not give her enough money to buy food for the children. She supposed that during the coffee season he earned double what he told her. She said that he was a drinker, smoked and took chat, a drug growing in this area. She complained that he disturbed the entire family every time he was home. She also said that they had land to cultivate, but he did not work on the farm. She argued that there weren't enough plants in the farm. She was thinking about leaving him, but was conscious about the fact that the children would be even worse off if she wasn't there anymore. The smaller child, which was still breastfed, finally developed marasmus, whereas the older child developed kwashiorkor. The children's mother admitted that she did not give enough care to the child before it developed oedema. Because of the home visits by the study team members, at which basic nutritional and health education was given, the mother started to gradually change her nutritional behaviour. She started to sell some of the kocho and bought some beans and oil for the children. The former kwashiorkor child eventually improved through her new behaviour. She also mentioned that the improvement of the child's nutritional situation was not because of more income from the coffee (at the

time of the interview it was coffee time), but because of the new knowledge she learnt from the survey team and applied.
The control family in the neighbouring house had even less cash money available and had even more family members to provide for. The important difference between the two households was, that the head of household was working on the farm, had a higher diversity of cultivation and did not sell foods rich in nutritional value such as avocado. His income came from the sale of coffee and sugar cane.
Because mothers of kwashiokor children complained they did not get enough money from their partner to buy food, many of them sold for example the avocados to get some more income. They themselves were not aware that avocados could help to improve the diversity of the child's diet. Before the home visits they preferred to sell avocados and buy additional kocho from the money earned.

One women, who presented one of her children with kwashiorkor to the Yirga Alem Hospital, lived alone with her four children. She had good farm land but because women in Sidama do not work in the garden, the garden was not cultivated with plants other than ensete and coffee. With the small amount of money she had at her disposal she sometimes bought beans or buttermilk for the children.

In some families it was mentioned that the mother became ill so she had to stop breastfeeding. The fathers said that the reason for kwashiorkor was the lack of breast milk. The problem in those families was that there was no knowledge of how to prepare appropriate weaning food for the children.

Two examples should be mentioned for an improper care alternative:
In one household with a former kwashiorkor child, the mother was a teacher, the father had a job in a farmers' organisation. The household was quite rich. A cupboard, a table, chairs to sit on and even a wooden bed was found in the house. The mother told the team members that while she was working in school she was not sure if the school girl which was supposed to take care of the young child was feeding the child taking care of it.

Another boy was already 12 years old when he was admitted to hospital with severe kwashiorkor. In the home visits it was seen that the grandmother was his caregiver. She also had to take care of another boy, who was older than the former patient. The grandmother was a very kind person, but as observations showed, she was neither controlling whether the children washed their hands before eating nor whether the children were eating or not. It was observed that the older boy took food from the younger one. The grandmother only prepared kocho, and sometimes kocho with gomen.

An example of a disorganised household can be demonstrated in the following example:

The child, 4 years old, was admitted with kwashiorkor to the hospital. It lived in an extreme unhealthy environment. The silo, where the kocho was fermented, was only partly covered. Flies and worms were seen in the kocho silo. At the same time the children used the place beside the kocho silo to urinate as there was no latrine. The child's mother was only gradually taking some of the advice given by the research team. Mostly the mother waited until her husband came home from his days work activity of collecting wood for cooking. If he hadn't collected wood in time, the woman started collecting wooden sticks shortly before cooking which, because of the often rain falls in this region, mostly wet. At one of the home visits it took her three hours to prepare lunch for the children.

The following provides an example of selfish parents who did not support their children:

The family, in which one of the children had kwashiorkor, was even richer than the control family in the neighbourhood, but the parents were using their income mostly for themselves. The mother of the patient went nearly daily to other people in the town to prepare injera, a kind of pancake made out of teff. Most probably she herself got food there to eat. It was observed that she also drank alcohol. The father also went often to the market and drank alcohol there. He did not bring food home for the children. Beside the selfishness of the parents, it was observed that they did not control whether the children ate enough or if they washed their hands

before eating. The older siblings also went out of the house to the neighbours or *to the market where, for example, they brought additional food when they sold some coffee beans.*

Another mother of a former kwashiorkor child planned to divorce her husband. She lived in polygamy. The man she planed to live with would not, according to the woman, accept the children from the former husband, so therefore she might leave the children behind with her husband. During the home visit it was obvious that she was not fulfilling her duties as a caregiver in a proper way. She did not work in the house, went and talked with neighbours while the child was eating, and also did not look after the child during the rest of the day. At each meal she gave left-over food to the child which was not re-heated. The neighbours said that they had the same quality of soil, but the difference was that they were busy in the garden and cultivated different plants. The father of the kwashiorkor child was a day worker and did not cultivate the garden with exception of the permanent plants ensete and coffee.

In one family the father and the oldest son were going out to sell products at the market or digging other families' farms, thus they had daily paid work. The mother went out of the house with the smallest child, which was being breastfed. Only the former kwashiorkor patient was in the house during the whole day. Sometimes the boy sat for about 3 hours alone in the house. The mother did not prepare the dinner on time. When the food was finally served, the child was too tired to finish it. The next morning he received the cold left-overs.

An example of inappropriate care for the child through the illness of the caregiver:
One of the mothers of a kwashiorkor child had a psychological problem. She had been married four times but every time the husbands left her because of her psychological problem. She had three children with her second husband. Two of them were, according to her, killed by other children of the polygamous husband. The 3rd one developed kwashiorkor. She finally moved with this child to the next husband.

After intensive home visits to families with kwashiorkor, marasmic and control children, it was concluded that there are the following differences between families with a kwashiorkor and a marasmic child:

- The families with a marasmic child are poor, very often to a higher extent than the families with a kwashiorkor child.
- The parents of marasmic children in general do not have problems between themselves. At least one parent, even in the case of a single mother, is treating the child in a nice way so that the child is not emotionally neglected. Observations and discussions showed that the kwashiorkor children are strongly neglected.
- The food the marasmic children get is far too little but not as unbalanced as in the case of kwashiorkor children.
- The nutritional and basic health advice given to parents of a marasmic child is followed faster than parents of a kwashiorkor child.
- In many households in which marasmic children are found TB or AIDS, as it was supposed, are common.

A comparison of a kwashiorkor and marasmic child of families living in the direct neighbourhood in Yirga Alem should be an example for the differences between families with a marasmic and a kwashiorkor child.

Excursus:

The mother of the kwashiorkor child was a single young woman. The child's father did not live with her. She took no time to care for the child. Although she had a small garden where some different foods were growing she was not using them. Moreover she was not working to obtain some income. At any time she was outside the house, meeting with neighbours, or going to other social events. The child was in a bad condition during the follow-up visits, it became oedematous and finally had to be admitted to hospital again. For the follow-up visits the mother sent someone else to take the child to hospital. For the hospital investigations she was called to come by one of the survey members. She finally excused herself for not coming because she wanted to go to a funeral. The next day, when she appeared *in hospital, she at once asked for permission to leave and for the hospital to make the child's investigations later because she wanted to go to another event. The child was neglected all the time.*

In the close neighbourhood there was a family with a marasmic child. They lived in a half damaged house. In parts of the house water was on the floor and it was very cold inside. The child's father was a tailor. It was observed that the family lacked food. The child was breastfed and got fresh cows milk as weaning food from 6 to 12 months of age. From the 12th month the mother started to give barley fluid. Thus the energy, especially the energy density, was much too low but unlike most kwashiorkor children the child was given fresh milk and a cereal based fluid. The parents both loved their child very much, they cleaned it and took care of it.

The following excursus tells about a family which had at the same time a kwashiorkor and a marasmic child. The family was visited two weeks after the children's discharge from hospital.

Excursus:

Patient data:K., boy, 7 years old, diagnosis at hospital admission: ***Kwashiorkor***
H., girl, 5 years old, diagnosis at hospital admission: ***Marasmus***
siblings

At the time of the field visit in July 1997 K. was marastic as well as H.. K. 's weight was 9,6 kg at the age of 7 years, H.'s weight was 10 kg at the age of 5 years.

The children, who are sister and brother, were admitted at Yirga Alem Hospital in June 1997. While the recovery of H. was no problem, she soon gained weight; the recovery of K. took 22 days with the new therapy. He was depressed and took a long time to show signs of improvement.

While discussing with the mother in the hospital about the illness and nutritional background of the patients, she pretended to give every time more and better food to K. According to the mother, the only difference between the children was, that K. suffered more often for different diseases and didn't eat so much fruits like H..

Two weeks after discharge from hospital, one of the study team was visiting the family and talked to all family members. She found out, that the mother had 7 children. One child died of measles at the age of 1 year. This child was born after H. At the time of the visit the mother had another baby, which was 1 year of age and breastfed.

According to the mother, the problems with K. started when he was 5 and half years old at the time the mother fell ill with TB. At this time the mother had a small child (H.), who was still breastfed. During the time of her illness, the mother was not able to make food. Mostly she laid on the bed while the older two brothers, at that time 7.5 and 11.5 years old, were cooking. It seemed, that these children didn't prepare food in the right way and nobody seemed to have controlled whether the child was eating or not and whether it washed hands before eating or not.

When the child was around 6 years and 10 months the child developed for the first time oedemas. Around that time the smaller sibling, who was born after H. died because of measles. Half a year later K. developed the second oedema before being admitted to hospital.

During the field visit two weeks after discharge of K., the interviewer found that the child did not get this nice food what the mother told us in the hospital. On that day the mother got one egg and she shared this in many parts for everybody instead of giving more to K.. K. got finally only 9 g egg. During discussion with the mother she mentioned that she gave K. as a weaning food from the 4th month on some butter milk and from the 6 month on only maize porridge without any additional food. Furthermore she gave bread and banana when the child was 10 month old. She also gave no avocado because they are, according to the mother, not necessary to small children. The difference according to the weaning food of H. was, that she added to the maize porridge some sugar and she gave at 11 months avocado. On the question why suddenly she gave avocado to small children, her answer was; she was so happy to have her first daughter. Both children got from the first day after birth water which was not boiled before drinking. The water seemed to be pure. According to the mother, H. liked fruits much more than K..

At the day of the field visit, K. behaved in a strange manner. He did not speak the whole day, e.g. when the mother asked him to bring her his coffee cup to give him *some coffee, he refused and showed an angry face to her. He also didn't answer to the questions of our team member. He was very angry the whole time. The grandfather, who lived in the neighbourhood told the team member, that the child, since it was small did never come to visit him in his house meanwhile his siblings did and got food sometimes at his place. The father of K. mentioned, that K. is always unhappy and strange to everybody.*

Our staff member than discussed a long time with the father of the children. He was asked why he thinks K. got this disease. ***The father said that the reason for this disease is a lack of food and at the same time a lack of care.*** *Because the mother was for some years ill, she didn't prepare food, only laid on the bed. He himself was a daily worker, he digged the garden of richer people, and he was out nearly every day from the morning till the evening. With the money he earned, he bought food at the market, mostly maize powder, gomen and sometimes red kidney beans. This food he brought to the older boys who cooked. He neither knew whether the older children gave food to K., nor if somebody controlled him. In the evening when he came home mostly he was very tired. According to him, K. didn't get enough food, if he got some it was very late.The father supposed that, because of this, the „oscars"- the intestine of the child- answered with decreased appetite. Furthermore he assumed, that the child didn't get enough care. Also nobody from the neighbours looked after the child, nobody asked for K. when he was treated in hospital.for 3 weeks.*

The mother at the time of the visit gave more care to the small 1-year-old baby. H. was a quite happy child talking a lot with the mother, running out to the grandfather's house, being very active. All the older children got some additional food from the garden (guavas at that time) or sometimes in the grandfather's house. Up to the time of the visit, the mother was week. Furthermore she didn't control the children. Leftover food she didn't heat in the evening.
Generally, nobody in the family got enough food. Only the strongest family members were able to go out and get additional food from outside. In the garden there was only ensete, some coffee and maize. All the bananas and avocados of the last year's harvest were sold. The house was very small, in a round shape and only 6 m diameter. Specially during the night time it was very cold in the house and the

rain entered the house because there were open areas. There was only one blanket used by the father and 3 children. The mother with the baby and H. used one gabi, a thin cotton made coverage. The night-clothes were not enough. The family only used wet wood from their garden to cook, which gave a lot of smoke.

Concerning advice for programmes it was learned from this study that the learning effect takes place very gradually, especially in families in which kwashiorkor occurs. In most cases changes in behaviour could be observed only at the third home visit. Advice given in the hospital often did not lead to a behaviour change. Only through home visits and discussions with the people about their situation and how to improve it, can positive results be observed. It became clear during the time of the study that not many organisations were working in the Sidama area despite the problem of malnutrition, especially kwashiorkor, being alarmingly high. Very often when the survey members were visiting the former patients and the control houses, the neighbours asked them to teach them, too. One of the farmers said "we all don't know how to cultivate our garden. It is necessary that everybody here is taught". There are villages in the Sidama area where no malnutrition is found because all families plant different foods in the garden and use the foods high in nutritional value such as butter, avocado or bananas for themselves. They could be involved as positive examples in a community programe.

9 RECOMMENDATIONS

In the Sidama zone Protein-Energy Malnutrition is a severe problem. In the year 1996 out of 1050 patients admitted to the children's ward in Yirgalem Hospital 7.9% were admitted with kwashiorkor and 8.7% with marasmus, which means that 17% of all patients admitted were severely malnourished. The milder forms of malnutrition are widely spread in Sidama. The experiences during this study show that nearly all families in the neighbourhood of the patients` had underweight children under five years of age. During the survey it was hard to find a household in which all children less than five years old had a weight for age index of over 80% of the reference standard (NCHS). It was learned from of the home visits that there is a vast need for community based nutrition and health communication programs. People insisted the research team members come and teach everybody in this region.

The prevalence or amelioration of malnutrition makes programs that touch both **macro social (governmental) and micro social aspects** necessary. Even in a nation that has increased its food production, if the distribution of wealth is not also changed, the lower socio-economic levels of the population will still be incapable of acquiring sufficient food, and little change will be seen in the nutritional status of their children (SOEKIRMAN in SUSKIND RM1990). Therefore, education, more rights for women, creating income possibilities, and a more equal distribution of wealth within a country should be part of **national development programs**.

On the **micro social level** an appropriate adjustment program in prevention of malnutrition has to be created through household and community action with active participation of people in Sidama.

The following aspects should be part of a community-based program:

1. Improving the health and nutritional situation of the families

There is a high need for nutritional and basic health education in the Sidama zone. As shown in this study there is a lack of nutritional knowledge. Many caregivers don't know that they can use most of the locally available food for their children. The role of mixtures (LEITZMANN and OLTERSDORF1982) (cereals and pulses, *kocho* and pulses) for the complementation of the aminoacid pattern, the importance of increasing the energy density of porridges by adding for example avocados, and the important role of fruits such as guavas, passion fruit and mango, has to be pointed out and should be integrated into the teaching program. Since the illness occurrence in the household turns out to be an important determinant of the development of kwashiorkor, nutrition and health programs should be addressed to the entire household to minimise the risk of the occurrence of kwashiorkor in a community. The caregivers show wrong behaviour concerning the prevention and treatment of illnesses. They withhold food and fluids, especially when children suffer from diarrhoea. After the end of the disease they don't give more food for recovery. Since the nutritional situation of children is highly linked to hygienic behaviour, at the same time it is necessary to teach them basic sanitary knowledge so that children get less infections (washing hands before touching food, covering leftovers, boiling water, which comes from an unprotected water source, cleaning the house and clothes etc.).The role of how to take care of young children (e.g. controlling that the children eat their food), especially those who are no longer breastfed should be pointed out in the education program.

2. Teaching how to use resources in a better way

- A practical approach to the problem is teaching how to use available foodstuffs in the diet of young children in a better way for example the simultaneous feeding of two mutually complementary plant protein foods given as a mixture (often of cereal and legume) (SAVAGE KING, 1992) by means of locally available home-economists. Teaching lessons and materials should include basic knowledge about breastfeeding and weaning food, taking into consideration cultural aspects of the Sidama people. Also the nutritional behaviour during and after diseases should be implicated, for example the avoidance of starvation in diarrhoeal disease.

- Encouraging people to use wood for fuel efficiently:

  I. To use wood stoves which use 30% to 50% less wood than cooking with three stones and which give less smoke

II. To dry firewood thoroughly and store it in a dry place. Dry wood gives more heat than fresh wet wood.

III. To prepare food in a way which reduces cooking time (e.g. soak leg umes before cooking).

- Teaching them how to diverse the agricultural pattern. The Sidama zone is a very fertile region in Ethiopia, but many households concentrate on the plantation of *ensete* and coffee. The *ensete* plant consists mainly of carbohydrate. If there are no other food items added to the diet it becomes very unbalanced; the children especially do not get enough energy, protein and micro-nutrients to grow. In the future there is a high need for teaching the people in a participatory way how to bring a higher variation of agricultural pattern in their gardens. The main part of the program must be to make the people believe that food diversity is good for the nutrition and health situation of the entire family and especially of young children. Using the garden for a higher food diversity such as beans, red kidney, chickpeas, *boyna*, potatoes and other vegetable beside *gomen* such as carrots, tomatoes should be promoted beside the traditional *ensete* and *gomen* cultivation. Also the importance of fruit trees, especially, avocado trees must be pointed out. The promotion of the use of indigenous food to offer supplementary, seasonal and emergency contribution to household food supplies should be involved in community programs.

- Teaching women to do some gardening: The women are depending too much on the men's power to work in the garden. As soon as the husband is ill or in the case that he dies, nobody tends to the garden. In this situation food shortage appears in the household. One quotation of a widowed mother with 4 children was „ we have a large plot of land, but nobody is here to farm. It is not my culture to farm. We have many food problems." To strengthen women's rights is a necessary step to reach this.

- Using goat milk as food, especially for children
  Since the rearing of cows in this area seems to be too expensive, especially for households where PEM occurs, the rearing of dairy goats and finally the consumption of goat milk should be advertised. Dairy goat rearing could be organized in

groups so that expenses for one household will be low. Compared to cow milk the lower curd tension of goat milk and the different chemical and physical composition of its fat suggests greater digestability. Apart from milk allergy, goat milk is a valuable aid in the problematic infant intolerant to formula derived from milk. An interesting observation which needs further investigation: goat milk has been used with great success in cases of post gastroentiritis as well as the initial stage of management of kwashiorkor where gastrointestinal hyper-sensitivity is experienced (http://www.goatconnection.com, accessed March 2003)

- Showing and encouraging people to repair their houses by simple methods when they are leaking and damaged: One of the risk factors for respiratory infections is a cold and damaged house especially during the night-time.

- Showing them how to use animal manure and plant waste to add to the soil in the garden.

- Proposing the Sidama people construct their houses in a way in which animal's excrement standing in the house could easily be gathered.

- Showing how to mulch, which means how to spread plant material like cut grass, *ensete* or banana leaves on the soil around the plants. This keeps soil dark, cool and moist and discourages weeds from growing. It reduces soil damage from heavy rainfall. The leaves rot down into the soil.

- Teaching them to use harvested foods rich in nutritional value for their own consumption instead of selling them, especially avocados, eggs, butter and cow milk.

- Teaching them agricultural methods to increase the harvest of their plants.

- Teaching how to avoid overgrazing by animals.

- Showing them how to store red kidney beans, chickpeas, beans etc. to overcome seasonal food shortage.

- Creating mills in a public place, where pulses and cereals could be ground. The keeping of the mills should be in the hands of responsible persons in the village

- Teaching them to use water not only for drinking and cooking but also for personal hygiene and for washing clothes.

- Teaching them to budget their wages so that they complement the basic foods with foods rich in nutritional value and keep enough money for the end of the month or times when food is scarce.

3. Program planers need to recognise Care as a crucial ingredient along with “food” and “health”.

As this study demonstrated clearly, care plays a significant role in the aetiology of PEM, especially kwashiorkor. Resources available at household and community level should be activated by different forms of communication to improve care, and hence nutrition. According to Longhurst and Tomkins (1995) children in especially difficult circumstances require special care interventions. Here especially children who experience frequent changes of mother-figures during the early years of life have to be given primary consideration. It is important to promote positive care behaviours such as allocating the household food supply to household members according to need, promoting the dietary intake of family members who are unwell, so that loss of appetite from infection or emotional stress is not accepted as an obligatory event. Encouragement to eat, especially during rehabilitation of diseases, coaxing, keeping food safe and dishes clean, the provision of alternative, appetizing food should be involved in promoting activities. A primary consideration must be given to the encouragement of health promoting behaviour such as the use of latrines and appropriate water supplies and the support of health seeking behaviour through regular visits to preventive and curative medical services. Positive care behaviours, the optimal use of resources available and the increase of social support in the family and community should correct the circumstances predisposing to malnutrition.

4. Helping households „at risk“ with micro-finance services

Households, who are too poor to get out of their situation, should get a „head start“ to improve their situation by micro-credit, which can be paid back later, by saving services or insurance.

Most of the patient’s families, especially those of kwashiorkor and marasmic, were poor, which means that the average monthly income is significantly lower than the Ethiopian national average. They don’t have enough bedclothes, household members don’t have enough clothes and shoes, the housing condition is not appropriate and they have perceived periods of food shortage during the year. Micro-credits should be given for example to buy a cow, a goat etc. or to buy material to start a small business (basket production, handicrafts etc.). Loans should also be given for landless people.

5. Providing the poorest of the poor with the necessities to survive

- Many of the patients’ families in this study don’t have enough bedclothes. Providing them with blankets would help them to avoid the risk of respiratory infections.
- Until they are able to cultivate a garden, families „at risk“ should be supplied with food.
- Micro-finance services should be addressed to them.

6. Monitoring and evaluation of the families’ situation

7. Methods to use for program planers:

To help people to learn how to improve the amount and type of food they eat and feed to their family, participatory rural approaches should be used. To reach more people it would be necessary to train community workers in caring aspects, agriculture, nutrition and basic health. As in this region the families have close contact to the neighbours, they meet nearly every day to drink coffee together, families in the neighbourhood who have a garden with a higher food diversity and well-nourished children could function as facilitators.
The design of communication materials should use methods with special consideration of the cultural context concerning basic knowledge about adequate nutrition (with

special emphasis on breastfeeding and weaning), recognition of early signs of malnutrition (hair changes, beginning of oedema) and avoidance of special risk factors (e.g. hygienic risk, food contamination etc.).

Coffee co-operations could be used to teach farmers how to plant agricultural products on their farms other than *ensete* and *gomen*.

Another important way to distribute knowledge is in school. According to a discussion with Dr. Melese Abebe, the medical doctor participating in this study, the most important aspect in the prevention of malnutrition in Sidama is to start at the young generation. To show students through school gardens how to diverse the agricultural pattern and to demonstrate them how to organise the household in a way to keep the family members in an aceptabel health and nutritional status is necessary to make a change.

Need for more research

The results from the logistic regression models might be useful for the application in surveys to find out those children at risk of malnutrition. Indices should be proven on a bigger sample of the population in Sidama but also in other regions and countries to finally formulate precisely those indicators for the practical application in the field. Since the results of this study point out the role of care in the development of severe malnutrition and kwashiorkor in particular, it would be advisable to create a behaviour index, which can be set up in shorter time.

Clinical studies should be carried out to closer define reasons for the “abdominal cramps” mentioned by caregivers and children themselves when kwashiorkor develops.

More clinical studies are necessary to enlighten the role of antioxidants in the prevention and treatment of severe malnutrition, especially in the case of kwashiorkor based on the results from the clinical study carried out in the frame of the overall “kwashiorkor project”, where this study also took place, at Yirga Alem Hospital lead by Prof. Dr. M. Leichsenring (prepared for publication).

10 SUMMARY

The present study was carried out within a wider research co-operation project between the Ethiopian Yirga Alem Hospital, Sidama, South Ethiopia, the Norwegian Lutheran Mission and the Children's University Hospital Heidelberg, Germany, to find out predisposing factors for the development of kwashiorkor, a severe form of protein-energy malnutrition (PEM).

The case-control study was composed of 106 children, PEM-children, who were treated in hospital, and controls from the neighbourhood. After discharge of hospital, they were followed for one year by 24-hour home visits between April 1997 and March 1998. During this time all households were visited every 4 months. Information was obtained through quantitative (questionnaires) and qualitative (structured observations, discussions) methods. Anthropometric measurements, weighing of food of the index children, interviews with caregivers and heads of household as well as observations were carried out.

The study contributes to the debate about whether children with nutritional oedema, compared to controls and to those with marasmus, were exposed more often to noxae that generate oxidative stress (hypothesis 1), or/and to factors that compromise defence against free radicals (hypothesis 2) and whether children with nutritional oedema, compared to controls and to those with marasmus, were exposed more often to a lack of care (hypothesis 3).

To get a closer inside view to predisposing factors for the development of kwashiorkor, analyses were performed according to three categories of classification, namely children who were once admitted to the Yirga Alem Hospital and classified as having kwashiorkor or marasmus. Controls were selected from the direct neighbourhood of the patients' families. The second classification is the grouping of the same children into oedematous and non-oedematous children after discharge from hospital. For the third classification of the sample, that is the post-kwashiorkor and post-marasmic children, only some investigations were carried out because of the small size of this sample.

The **main objectives** of the study were to examine predisposing factors for the development of kwashiorkor based on the concept of immediate, underlying and basic causal factors. The immediate factors comprise nutritional intake of the index children and the morbidity of the index children and their families. Underlying and basic predisposing factors include socio-economic and environmental factors, caring capacity, nutritional knowledge and nutritional behaviour of the caregivers.

The **most important determinants for the development of kwashiorkor** were examined by a final logistic regression model. The determinant with the strongest impact on the occurence of nutritional oedema in this model turns out to be the **behaviour of the caregivers concerning childcare** (p=0.007), one of the factors belonging to the underlying causal determinants of kwashiorkor. The investigation of the caring environment of the malnourished child reveals severe household disorganisation and extensive family disruption. Resources available were not used in a way to ensure the health of the children. According to the classification of care done in this study, only good care protects from nutritional oedema. The better the care was, the better also was the fulfilment of the requirements of main nutrients. Children who got only medium or bad care were over represented in the lowest classes of adequacy of main nutrients. There was a strong negative relationship between care and the occurrence of nutritional oedema (r=-.42; p= 0.000).

Another important risk factor is the **occurence of diseases in the household**. If one additional illness in the household occurred, the risk for the index child to become oedematous increased by the factor 1.476. In the pre-harvest season, when food availability was lower, more children became oedematous with the typical complications appearing together or before the oedema occured.

Oedematous children were not exposed to a special pattern of infection, but the suffered diarrhoea significantly more often . The typical symptoms occurring together or before the oedema were diarrhoea, abdominal cramps, loss of appetite and often vomiting. These symptoms were found significantly more often in the oedematous patients.

Oedematous children were exposed significantly more often to diseases, but not to any specific one. The risk of becoming oedematous was higher if the number of diseases the child was exposed to increased. In the pre-harvest season illnesses were more frequent in all households. The results show that in the households where a child got oedema, the other household members were more often exposed to any kind of illnesses. The differences were also seen when only post-kwashiorkor children were compared with post-marasmic children. More post-kwashiorkor children suffered from at least one disease during the study period and also the other household members of the households with a post-kwashiorkor child were ill more often than those of the post-marasmic children. Care seems to play an important role in these households. The frequency of infections and the nutritional intake of the studied index children means that nutritional deficits were not being appropriately corrected and the consequence was a constant morbidity.

Concerning the impact of **nutritional factors**, the strongest item for the development of kwashiorkor was the **Fat Energy Ratio** (FER) (p=0.020). The FER for the oedematous children was below 10 percent throughout all seasons, with the lowest value in the pre-coffee season (6%). The difference between the two groups was highly significant for the pre-coffee season (p=0.005).

The result of the model reveals the fact that **the quality of protein (p=0.022) is a more important determinant for the occurence of nutritional oedema than the quantity of protein** (p=0.192).

The post-marasmic children consumed more often, across all seasons investigated, maize and beans. Especially in the post-harvest season the marasmic children seemed to have a higher food variety. They consumed protein rich foods such as buttermilk and beans more often.

The post-kwashiorkor group had a better supply of all nutrients during the coffee-season. As it was confirmed by the group of oedematous children compared to the non-oedematous children, the post-kwashiorkor children had a deficient supply of several nutrients over a long period of time (about 8 months), especially fat, thiamine, niacin and vitamin C. The post-kwashiorkor children had -compared to the post-marasmic children- an especially low intake of thiamine (p=0.044) and niacin throughout the year of investigation. Not even 50% of the recommended intake was fulfilled. On the other hand, the post-marasmic children had a lower intake of vitamin C and calcium. In general the energy intake of the post-marasmic children was too low throughout the year, even in the coffee-season, but with all other nutrients and micro-nutrients investigated they were better off in the post-harvest season than the post-kwashiorkor children.

The main proportion of energy of the children's diet was derived from carbohydrate resulting mainly from the dominant role of the starchy food items *ensete* and maize. With the exception of the coffee season, between 85% and 90% of the energy in the diet of the oedematous children was derived from carbohydrates and the percentage derived from fat and protein was correspondingly low. Concerning the post-kwashiorkor and the post-marasmus group the contribution of all nutrients to the total energy intake was significantly different for the pre-coffee season: for carbohydrate: p=0.024, for protein p=0.006 and for fat p=0.044. The percentage of carbohydrate calories to the total energy intake was on average higher for the post-kwashiorkor children than for the post-marasmic children (91.2% and 84.9% respectively). The protein calories were 5.0% lower than the protein calories of the post-marasmic children (7.8%) and also the fat calories were lower for the post-kwashiorkor children (5.7% compared to 9.0% of the post-marasmic children). Throughout all seasons the contribution of carbohydrates to the total energy was higher for the post-kwashiorkor children compared to the post-marasmic children, whereas the contribution of fat- and protein calories to the total calories was lower.

The determinant of food diversity in the household of the index child turns out to be another significant risk factor (p=0.042) for the development of kwashiorkor. The non-oedematous households purchased other cereals in addition to the main starch foods *ensete* and maize, especially teff, but also pulses. Moreover foods rich in fat were available in their diet to a significantly higher extent. Especially for children of the oedematous group, who were too young or too weak to get additional food outside their own house, the diet was extremely unbalanced, based only on *ensete*, maize and some *gomen*, thus lacking foods rich in special amino acids, micronutrients and fat in general. The number of all different foods available throughout the seasons was higher in households with post-marasmic children than in households with post-kwashiorkor children.

The results of the study show that the interaction of socio- cultural factors, especially the role of care for the child, and biological factors were strongly involved in the causation of the disease. It could be demonstrated that the oedematous children were exposed to increased stress, either psycho-social stress caused through a lack of care or through increased infective episodes. Thus, concerning **hypothesis 1**, it can be concluded that oedematous children especially were more exposed to noxae that generate oxidative stress than healthy children or even marasmic children were. Oedematous children had in comparison to non-oedematous children a lower intake of factors that compromised defence against free radicals **(hypothesis 2)**. The absolute intake of sulphur-containing amino acids, but especially the intake of B vitamins (thiamine) which are involved in the maintenance of the antioxidant system, were considerably lower for the oedematous children compared to the non-oedematous but also for the post-kwashiorkor compared to the post-marasmic children. It could be concluded that **hypothesis 3** is true, since most oedematous children were growing up in a non-supportive family structure and could not have expected adequate care. Resources available were not used in a way to support the health of the children.

On the micro social level an appropriate adjustment program in prevention of malnutrition has to be created through household and community action with the active participation of people in Sidama. Program planers need to recognise Care as a crucial ingredient along with “food” and “health”. The most important determinants for the development of kwashiorkor might be useful for the application in surveys to discover children at risk of malnutrition. Determinants found should be proven on a bigger sample of the population in Sidama but also in other regions and countries to finally formulate precisely those indicators for the practical application in the field.

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ANNEX

ANNEX A: TABLES

Annex A 4 – 1: Average *per capita* income, total expenditures, expenditures for food, food budget share for the groups during the seasons

	Whole study period				Seasons											
	April 1997 - March 1998				April - July				August - November				December – March			
Income, expenditures in groups	**Mean per capita income/expenditures ±SD**	**n**	**Per month**	**% food budget share**	**Mean per capita income/expenditures ±SD**	**n**	**Per month**	**% food budget share**	**Mean per capita income/expenditures ±SD**	**n**	**Per month**	**% food budget share**	**Mean per capita income/expenditures ±SD**	**n**	**Per month**	**% food budget share**
Income																
Control	222.8 ±169.3	25	18.5		71.7 ±52.4	27	17.9		76.5 ±56.4	28	19.2		73.7 ±74.7	27	18.3	
Kwashiorkor	138.1 ±116.9	54	11.5		41.2 ±38.3	56	10.3		57.4 ±42.2	57	14.4		39.6 ±46.6	55	9.9	
Marasmus	139.2 ± 81.1	15	11.6		38.2 ±25.9	18	9.6		46.3 ±23.5	18	11.6		51.4 ±37.3	15	12.9	
NO-households	190.5 ±153.7	59			57.9 ±42.7	65			67.8 ±49.7	67			62.8 ±66.3	61		
Oed.households	110.7 ± 60.9	35			34.4 ±33.1	36			47.3 ±30.9	36			30.9 ±21.7	36		
Expenditures total																
Control	199.1 ±144.4	25	17		58.5 ±43.1	27	15		69.4 ±47.4	28	17		71.9 ±73.7	27	18	
Kwashiorkor	143.0 ±121.7	54	12		40.5 ±41.7	56	10		62.3 ±47.0	57	16		39.6 ±46.6	55	10	
Marasmus	141.6 ±70.7	15	12		37.3 ±24.4	18	9		48.5 ±21.1	18	12		51.4 ±37.3	15	13	
NO-households	181.0 ±142.2	59			50.5 ±42.7	65			66.6 ±48.8	67			6 1.9 ±65.6	61		
Oed.households	118.4 ±67.7	35			34.4 ±33.1	36			52.8 ±31.6	36			30.9 ±21.7	36		
Expenditures for food																
Control	147.7 ±117.2	25	12	74.5	46.9 ±34.6	27	12	80.2	46.2 ±31.8	28	12	66.6	53.1 ±60.4	27	13	73.2
Kwashiorkor	84.9 ±57.8	54	7	59.9	27.5 ±18.1	56	7	69.3	33.4 ±22.0	57	8	53.6	24.6 ±27.0	55	6	62.1
Marasmus	98.5 ±47.4	15	8	69.6	28.7 ±16.2	18	7	76.9	32.5 ±13.5	18	8	67.0	34.7 ±25.5	15	9	67.5
NO-households	124.0 ±92.6	59			38.1 ±27.0	65		69.1	41.7 ±26.4	67		66.2	42.9 ±48.3	61		69.9
Oed.households	69.6 ±35.8	35			23.0 ±16.1	36		62.4	27.5 ±17.1	36		57.6	19.0 ±12.0	36		67.8

p<0.05	p<0.01

Annex A 4 – 2: Frequency distribution of households with children according to clinical classification in hospital (Kwashiorkor (K), Marasmus (M), and Control (C)) in the tercile groups with respect to income, total expenditures and expenditures for food

	Whole study period (April 1997 - March 1998)			Season (April - July)			Season (August - November)			Season (December - March)		
	C	K	M	C	K	M	C	K	M	C	K	M
Income	n=25	n=54	n=15	n=27	n=56	n=18	n=28	n=57	n=18	n=27	n=55	n=15
low	16.0	42.6	26.7	18.5	41.1	33.3	25.0	35.1	38.9	18.5	41.8	26.7
medium	36.0	31.5	40.0	22.2	35.7	44.4	28.6	33.3	44.4	37.0	32.7	33.3
high	48.0	25.9	32.3	59.3	23.2	22.2	46.4	31.6	16.7	44.4	25.5	40.0
Total expenditures												
low	20.0	37.0	40.0	14.8	42.9	33.3	25.0	35.1	38.9	18.5	41.8	26.7
medium	36.0	37.0	20.0	33.3	30.4	44.4	39.3	29.8	38.9	37.0	32.7	33.3
high	44.0	25.9	40.0	51.9	26.8	22.2	25.7	35.1	22.2	44.4	25.5	40.0
Expenditure for food												
low	20.0	42.6	20.0	22.2	40.0	27.8	25.0	38.6	27.8	25.9	40.0	20.0
medium	24.0	33.3	53.3	22.2	34.5	50.0	21.4	35.1	50.0	22.2	41.8	33.3
high	56.0	24.1	26.7	55.6	25.5	22.2	53.6	26.3	22.2	51.9	18.2	46.7

Significance levels between the investigated groups:

p< 0.05

p< 0.001

Annex A 4 – 3: Frequency distribution of households with children according to classification after discharge from hospital (non-oedematous (NO), oedematous (O)) in the tercile groups with respect to income, total expenditures and expenditures for food

	Whole study period (April '97 – March'98)		Season (April - July)		Season (August - November)		Season (December - March)	
	Oede-matous	**Non-oedema-tous**	**Oede-matous**	**Non-oedema-tous**	**Oede-matous**	**Non-oedema-tous**	**Oede-matous**	**Non-oedema-tous**
Income	n=35	n=59	n=35	n=65	n=36	n=67	n=36	n=61
low	48.6	23.7	52.8	23.1	50.0	23.9	41.7	27.9
medium	31.4	35.6	30.6	35.4	25.0	38.8	33.3	34.4
high	20.0	40.7	16.7	41.5	25.0	37.3	25.0	37.7
Total expenditures								
low	45.7	25.4	50.0	24.6	47.2	25.4	41.7	27.9
medium	31.4	35.6	27.8	36.9	22.2	40.3	33.3	34.4
high	22.9	39.0	22.2	38.5	30.6	34.3	25.0	37.7
Expenditure for food								
low	45.7	25.4	51.4	23.1	50.0	23.9	41.7	27.9
medium	42.9	28.8	31.4	35.4	33.3	34.3	44.4	29.5
high	11.4	45.8	17.1	41.5	16.7	41.8	13.9	42.6

Significance levels between the investigated groups:

p< 0.05

p< 0.001

Annex A 4 – 4: Mean amount of Birr spent for different foods during the seasons

Season	(April – July)		(August - November)		(December - March)	
Food items or groups/ groups investigated	**Oede-matous**	**Non-oedema-tous**	**Oede-matous**	**Non-oedema-tous**	**Oede-matous**	**Non-oedema-tous**
	n=36	n=65	n=36	n=67	n=35	n=61
Maize						
Mean	48.7	55.1	47.4	50.4	29.5	46.3
Median	40.0	55.0	41.5	50.0	30.0	33.0
Ensete						
Mean	19.6	11.1	17.8	94.0	6.7	11.5
Median	0	0	0	0	0	0
Cereals						
Mean	2.2	32.9	2.0	35.6	3.3	50.5
Median	0	0	0	0	0	0
Pulses						
Mean	10.9	27.8	30.0	47.6	22.5	37.7
Median	4.0	18.0	19.3	40.0	16.0	28.0
Gomen						
Mean	12.3	16.4	22.0	19.7	18.8	16.8
Median	0	12.0	21.0	20.1	20.4	16.0
Roots						
Mean	0	2.2	0	0.2	0	2.1
Median	0	0	0	0	0	0
Animal products						
Mean	4.8	8.3	5.6	10.0	6.4	11.7
Median	0	0	0	0	0	0
Foods rich in fat						
Mean	7.3	13.6	7.1	15.3	8.8	21.0
Median	5.3	9.3	6.5	11.0	8.0	12.0
Spices						
Mean	11.0	14.4	15.5	17.9	14.4	19.12

Median	7.2	12.0	12.0	17.0	12.0	16.0

Annex A 4 – 5: Farmers with harvest, agricultural production (kg) of farmers during the seasons and usage pattern

	Seasons											
	April - July				August - November				December - March			
Food items in investi-gated groups	Farmers with har-vest n (%)	Harvest Mean (kg) ±SD	Own con-sump-tion (%)	Sold (%)	Farmers with harvest n (%)	Harvest Mean (kg) ±SD	Own con-sump-tion (%)	Sold (%)	Farmers with har-vest n (%)	Harvest Mean (kg) ±SD	Own con-sump-tion (%)	Sold (%)
Ensete		**,++,x		***,+++	*					**,++		
Control	18 (75.0)	114.7 ±41.2	83.9	16.1	22 (88.0)	125.1 ±56.7	92.1	8.0	19 (82.6)	148.2±66.8	83.6	15.1
Kwash.	37 (71.2)	72.2 ±34.1	100.0	0	43 (81.1)	88.2 ±44.8	96.9	3.1	34 (86.7)	96.9±47.6	93.0	7.0
Marasmus	10 (62.5)	72.0 ±36.4	100.0	0	9 (56.3)	88.9 ±44.6	100.0	0	7 (58.3)	96.0±41.3	100.0	0
Coffee												
Control	0	0	0	0	19 (72.0)	141.3 ±121.0	38.1	50.4	3 (13.0)	94.2 ±80.3	45.1	56.8
Kwash.	0	0	0	0	43 (81.1)	101.5 ±75.0	45.3	44.5	6 (11.8)	119.0 ±165.5	25.8	68.7
Marasmus	0	0	0	0	11 (68.8)	82.5 ±43.4	40.6	50.3	2 (16.7)	190.0 ±191.0	19.1	80.9
Maize												
Control	3 (12.5)	236.7 ±164.4	100.0	0	23 (88.0)	206.1 ±169.3	88.0	4.6	0	0	0	0
Kwash.	12 (23.1)	99.3 ±88.5	95.8	0	42 (79.2)	122.3 ± 89.5	96.2	2.4	0	0	0	0
Marasmus	1 (6.3)	33.0 ±0	100.0	0	12 (75.0)	97.5 ± 61.5	94.4	0	0	0	0	0
Cabbage												
Control	21 (87.5)	65.6 ±32.6	100.0	0	9 (36.0)	33.5 ±13.8	100.0	0	0	0	0	0
Kwash.	40 (76.9)	42.9 ±26.8	97.9	0	23 (43.4)	35.8 ±20.2	97.8	2.2	0	0	0	0
Marasmus	13 (81.3)	40.5 ±22.7	100.0	0	6 (37.5)	33.8 ±16.5	100.0	0	0	0	0	0
Beans	*, +, x											
Control	16 (66.7)	43.8 ±22.0	100.0	0	6 (24.0)	31.0 ±13.5	100.0	0	0	0	0	0
Kwash.	21 (40.4)	39.9 ±27.6	90.5	9.5	13 (24.5)	34.8 ±22.9	100.0	0	0	0	0	0
Marasmus	4 (25.0)	49.3 ±31.6	100.0	0	2 (12.5)	36.0 ±17.0	100.0	0	0	0	0	0

* significance between the groups, + significance between control and kwashiorkor group, x significance between control and marasmus group

Annex A 4 – 5 continued: Farmers with harvest, agricultural production (kg) of farmers during the seasons and usage pattern

	Seasons											
	April - July				August - November				December - March			
Food items in investi-gated groups	**Farmers with harvest n (%)**	**Harvest (kg) ±SD**	**Own con-sumption (%)**	**Sold (%)**	**Farmers with harvest n (%)**	**Harvest (kg) ±SD**	**Own con-sump-tion (%)**	**Sold (%)**	**Farmers with har-vest n (%)**	**Harvest (kg) ±SD**	**Own con-sump-tion (%)**	**Sold (%)**
Roots	***,++											
Control	13 (54.2)	70.2 ±34.6	93.1	6.9	4 (16.0)	65.5 ±38.1	87.5	12.5	0	0	0	0
Kwash.	9 (17.3)	47.8 ±28.3	92.6	7.4	5 (9.4)	196.8 ±236.8	73.3	26.7	0	0	0	0
Marasmus	2 (12.5)	46.0 ±19.8	100.0	0	0	0	0	0	0	0	0	0
Avocado												
Control	5 (20.8)	70.0 ±48.0	66.7	33.3	6 (20.0)	56.7 ±29.4	94.4	5.6	4 (17.4)	55.0 ±58.0	69.1	
Kwash.	6 (11.5)	24.3 ±14.0	50.0	50.0	16 (30.2)	68.8 ±45.6	51.6	48.4	4 (7.8)	45.0 ±37.9	76.9	23.1
Marasmus	1 (6.3)	40.0 ±0	100	0	3 (18.8)	40.0 ±0	66.7	33.3	2 (16.7)	30.0 ±14.1	50.0	50.0
Banana	*,+,x								*, +			
Control	19 (79.2)	3.8 ±3.2	64.9	35.1	17 (64.0))	3.4 ±2.3	66.6	33.4	13 (56.5)	4.2 ±2.7	41.3	58.7
Kwash.	24 (46.2)	2.9 ±2.6	30.3	65.5	23 (43.4)	3.2 ±2.5	40.9	59.1	14 (27.5)	3.9 ±2.5	23.4	76.6
Marasmus	7 (43.8)	2.9 ±2.3	50.0	50.0	6 37.5)	2.5 ±2.1	65.3	34.7	3 (25.0)	7.7 ±4.9	26.7	70.3
Other fruits	*											
Control	7 (29.2)	24.1 ±16.5	90.5	9.5	3 (12.0)	25.3 ±17.2	100.0	0	1 (4.3)	30 ±0	50.0	50.0
Kwash.	4 (7.7)	47.5 ±12.9	64.6	35.4	4 (7.5)	48.8 ±35.4	49.5	50.5	1 (2.0)	20 ±0	0	0
Marasmus	2 (12.5)	49.0 ±55.2	75.0	25.0	2 (12.5)	44.0 ±0	100.0	0	1 (8.3)	5 ±0	0	0

* significance between the groups, + significance between control and kwashiorkor group, x significance between control and marasmus group

Annex A 4 – 6: Animal husbandry: households owning livestock, average number of livestock

Animals	Households, who own animals n (%)	Number of animals No ±SD
Control	1 (3.3)	1±0
Kwash.	0	0
Marasmus	0	0
		*
Control	1 (3.3)	2.0 ±0.2
Kwash.	4 (6.9)	1±0
Marasmus	0	0
Control	19 (63.3)	3.4 ±1.5
Kwash.	37 (63.8)	2.1 ±1.1
Marasmus	9 (50.0)	2.1 ±0.8
Control	8 (26.7)	1.6 ±1.1
Kwash.	10 (17.2)	2.0 ±1.1
Marasmus	1 (5.6)	3.0 ±0
Control	5 (16.7)	2.2 ±0.5
Kwash.	10 (17.2)	1.4 ±0.7
Marasmus	0	0
	*	
Control	21 (19.8)	4.8 ±3.7
Kwash.	27 (25.5)	3.6 ±2.7
Marasmus	6 (5.7)	3.7 ±2.2

* $p<0.05$ significance between the groups

Annex A 4 – 7: Products from livestock (cowmilk, eggs): households who had animals with production, mean number of product, usage pattern in the seasons

	Seasons							
	April - July				August - November			
Food items in groups investi-gated	Households with pro-ducing animals n (%)	Amount (l/no) l/no ± SD	Own consum-ption (%)	Sold (%)	Households with milk producing cows n (%)	Amount (l/no) l/no ± SD	Own con-sump tion (%)	Sold (%)
I)				*				
Control	9 (47.4)	148.0±58.8	83.3	16.7	15 (78.9)	120 ±54.5	93.3	6.7
Kwash.	7 (18.9)	107.1±25.1	64.3	42.9	13 (35.1)	114.6 ±53.8	76.9	23.1
Marasmus	2 (22.2)	120.0 ±0	75.0	12.5	4 (44.0)	117.0 ±88.9	87.5	25.0
Control	7 (33.3)	77.1 ±34.0	100	0	11 (52.4)	53.2 ±31.7	87.2	12.8
Kwash.	7 (25.9)	38.1 ±17.0	88.5	11.5	8 (29.6)	49.5 ±29.6	100	0
Marasmus	1 (16.7)	120 ±0	50.0	50.0	2 (33.3)	30.0 ±0	100	0

* $p<0.05$ significance between the groups

Annex A 4 – 8: Variables included in the hygiene index and their relevance (expressed in significance level) to the occurrence of diarrhoea

Significance level	p>0.10	0.05<=p<=0.10	0.01<p<0.05	p<=0.01
Variables	Clean clothes	Hands of index child clean	Hygiene of drinking water	Cooking utensils clean
	Contact with dirt on the floor	Hands of caregiver clean	Prepared food left over was covered	Flies in the house
	Rodents in the house	Hole where *kocho* is stored clean		Floor cleaned
		Food warmed up, if later eaten		Hands of caregivers washed before cooking

Annex A 4 – 9: Scoring system for different child care practices and resources included in the various indices forming the care index for non-oedematous (NO) and oedematous (O) children

Childcare practices, behaviours and resources included in the different indices	Scores allocated to different variables	NO n=69 (%)	O n=37 (%)
Index of household organisation:			
Bed facilities	Bad: -1 Medium: 0 Good: 1	26 29 45	65 * 24 11
Wet wood used for cooking	Yes: -1 No: 0	Yes: 20	Yes: 54*
Food prepared from the caregiver too late	Yes: -1 No: 0	Yes: 38	Yes: 87*
Coldness through the night in the house	Yes: -1 No: 0	Yes: 28	Yes: 68*
Rain coming through the house (leaking house)	Yes: -1 No: 0	Yes: 13	Yes: 38*
Lack of night blankets etc.	Yes: -1 No: 0	Yes: 38	Yes: 73*
Index of problems perceiving in the households:			
Head of household drinker	Yes: -1 No: 0	Yes: 12	Yes: 22
Head of household smoker	Yes: -1 No: 0	Yes: 6	Yes: 11
Head of household ill	Yes: -1 No: 0	Yes: 10	Yes: 14
Social contacts of parents	Yes: 1 No: 0	Yes: 23	Yes: 35
Caregiver somebody else than mother	Yes: -1 No: 0	Yes: 12	Yes: 8
Head of household somebody else than father	Yes: -1 No: 0	Yes: 6	Yes: 3
Head of household dead or not around	Yes: -1 No: 0	Yes: 12	Yes: 27*
Often quarrels between head of household and caregiver	Yes: -1 No: 0	Yes: 13	Yes: 24
Financial problems	Yes: -1 No: 0	Yes: 33	Yes: 65*
Index of behaviour of caregiver towards the index child:			
Control if child eats the prepared food	Yes: 1 No: 0	Yes: 71	Yes: 35 *
Control of hygiene of the child	Yes: 1 No: 0	Yes: 52	Yes: 22 *
Occupation with the child	Yes: 1 No: 0	Yes: 73	Yes: 35 *
Preference of any other child(ren)	Yes: -1 No: 0	Yes: 23	Yes: 54 *
Neglecting the child	Yes: -1 No: 0	Yes: 17	Yes: 32
Caregiver too inactive	Yes: -1 No: 0	Yes: 17	Yes: 41 *
Caregiver too active	Yes: -1 No: 0	Yes: 16	Yes: 19
No control for child at all	Yes: -1 No: 0	Yes: 38	Yes: 73 *
Caregiver ill	Yes: -1 No: 0	Yes: 16	Yes: 27
Sibling of index child was breastfed at the time of the study	Yes: -1 No: 0	Yes: 52	Yes 70

* Significance level p<0.05

Annex A 4 – 9 continued: Scoring system for different child care practices and resources included in the various indices forming the care index for non-oedematous (NO) and oedematous (O) children

Childcare practices, behaviours and resources included in the different indices	Scores allocated to different variables	NO n=69 (%)	O n=37 (%)
Health prevention index:			
Use of health care services	Yes: 1 No: 0	Yes: 80	Yes: 78
Child immunised	Yes: 1 No: 0	Yes: 66	Yes: 42*
Child got colostrum	Yes: 1 No: 0	Yes: 33	Yes: 36
Total Health prevention index:	0 –1 scores	27	44*
	2 – 3 scores	73	56
Knowledge index:			
Colostrum given after birth	Yes:1 No: 0	Yes: 33	Yes: 36
Herbs given shortly after birth	1-120 days after birth:-1	Yes: 67	Yes: 73
	>120 days after birth: 0	Yes: 1	Yes: 1
	Not given: 1	Yes: 32	Yes: 22
Duration of breastfeeding	1-6 month: 0	Yes: 6	Yes: -
	>6 month,: 1	Yes: 94	Yes:100
Unboiled water not given for drinking shortly after birth	Yes: 1 No: 0	Yes:75	Yes: 64
Reason for stopping breast-feeding	Mother sick, -1 Parents separated, mother died	Yes: 59	Yes:84*
	New pregnancy: 0 Child don't want to take breast	Yes:41	Yes:16
Start of weaning		Mean (months) ±SD 5.65±1.84	Mean (months) ± SD 6.19±2.10
Range of weaning time	< 6 months: 0	Yes: 24	Yes: 25
	6 months and more: 1	Yes: 76	Yes: 75
Sum of different foods given to the index child during weaning period	Every food was allocated with score +1, scores were summed	Mean no. of scores ±SD: 3.80 ± 1.56	Mean no. of scores ±SD: * 3.0±1.18
Hygiene index			
Weighing scores according to significant relation to the occurrence of diarrhoea	Computation see above	Mean ± SD: 12.45 ±4.84 (Median: 14.5)	Mean ± SD: * 7.5 ±6.32 (Median: 9.0)

* Significance level p<0.05

Annex A 5 – 1: Seasonal influences on the mean adequacy ratio for various nutrients of oedematous and non-oedematous children

(trimmed mean for main nutrients, outlier for micronutrients: Fe, B1, B2, Vitamin C)

Seasons / Groups		Mean Adequacy Ratio for Various Nutrients (Nutrient Intake as Percent of RDA)									
		Energy	Protein	Fat	Calcium	Iron	Phos-phorus	Thiamine	Riboflavin	Niacin	Vitamin C
April - July											
Oedematous	Mean	64.6	61.5 (*)	20.1 (*)	76.8	113.0	95.8	48.5	62.9 *	40.5	54.1
	SD	32.6	50.4	19.9	50.8	57.0	68.2	47.7	33.3	29.7	66.9
	Median	59.6	54.6	14.6	71.1	103.7	76.6	30.0	61.0	34.8	36.3
Non-oed.	Mean	74.3	90.4	37.1	77.5	135.4	120.8	64.3	87.3	53.6	65.8
	SD	36.5	69.9	27.7	40.5	86.2	94.7	40.6	54.1	37.1	87.1
	Median	68.7	76.4	31.0	70.1	113.9	104.3	55.7	74.0	47.7	42.1
August - November											
Oedematous	Mean	83.7 *	95.0 (*)	33.2	87.6	155.2	139.3	77.5	97.0 *	54.0 *	54.1
	SD	49.9	52.2	31.0	74.6	99.5	59.5	42.3	79.9	27.9	45.6
	Median	76.8	96.5	29.2	74.0	132.0	146.3	67.9	71.3	49.2	51.1
Non-oed.	Mean	106.3	129.0	49.2	113.1	192.2	174.6	97.6	124.0	66.3	62.7
	SD	53.0	84.3	42.3	66.6	131.4	108.3	60.7	72.7	32.5	40.9
	Median	102.6	114.7	39.5	103.8	148.0	152.1	84.3	107.7	59.1	61.1
December - March											
Oedematous	Mean	61.6 *	69.1 **	23.0 **	77.4 *	98.9 ***	86.9 **	54.0 *	79.2 ***	36.8 *	60.7
	SD	40.0	90.7	24.9	47.0	49.2	75.4	56.9	53.4	25.0	38.3
	Median	60.7	60.9	17.6	71.3	91.9	75.3	35.0	69.6	33.7	58.3
Non-oed.	Mean	94.9	115.4	43.9	116.7	181.1	151.8	82.5	148.8	56.3	82.1
	SD	45.1	66.5	30.1	89.1	110.0	108.0	64.0	140.4	38.1	72.4
	Median	88.4	95.3	38.7	121.6	178.1	123.0	58.8	122.5	47.6	61.8

Asterisk/s denote a significant difference in the mean nutrient intake adequacy of children belonging to the oedematous group and non-oedematous group

*p<0.05,**p<0.01,***p<0.001,(*)p<0.1

Annex A 5 – 2: Seasonal influences on the mean adequacy ratios for various nutrients of ex-kwashiorkor, ex-marasmic patients and controls (outlier removal or trimmed mean)

Seasons / **Groups**	**Mean Adequacy Ratio for Various Nutrients (Nutrient Intake as Percent of RDA,DRI)**									
	Energy	Protein	Fat	Calcium	Iron	Phos-phorus	Thia-mine	Ribofla-vin	Niacin	Vitamin C
April – July										
Control										
Mean	101.9 **	115.5*	44.9 **	104.4	144.8 *	153.0 *	70.8	112.8 *	62.8	66.2
SD	33.5	78.2	18.7	47.2	48.1	73.8	45.8	58.1	24.0	109.4
Median	95.3	86.8	41.0	108.0	145.5	140.6	58.7	97.0	58.5	36.2
Kwashiorkor										
Mean	60.5	63.9	21.7	71.8	119.7	96.4	53.4	66.2	43.6	66.6
SD	26.6	45.7	14.2	42.4	72.8	58.7	42.1	40.6	35.5	77.7
Median	55.3	61.5	18.4	67.0	96.8	88.3	46.0	61.0	41.7	42.2
Marasmus										
Mean	74.2	111.3	30.0	61.7	141.4	120.7	66.1	84.2	54.3	32.1
SD	44.1	90.3	25.4	29.0	131.0	86.8	46.3	48.0	46.4	36.9
Median	68.4	92.3	30.6	63.8	111.8	107.7	65.2	65.8	46.1	26.9
August – Nov.										
Control										
Mean	135.4 ***	208.1***	73.5 ***	167.6 ***	281.9 **	221.3 ***	139.2 *	172.7 **	89.1 **	73.6 (*)
SD	66.6	89.4	57.8	66.4	140.1	107.9	66.2	60.9	33.7	37.3
Median	113.6	202.6	60.4	162.0	266.9	209.9	128.3	176.8	87.0	77.7
Kwashiorkor										
Mean	70.8	92.1	25.3	84.7	156.4	116.1	75.4	99.2	54.2	57.2
SD	31.2	48.5	13.6	58.1	105.7	56.3	40.1	76.0	26.3	45.2
Median	65.1	88.6	22.5	76.9	132.0	110.5	67.2	75.5	49.8	53.9

Asterisk/s denote a significant difference in the mean nutrient intake adequacy of control, ex- kwashiorkor and ex-marasmic children

*p<0.05,**p<0.01,***p<0.001,(*)p<0.1

Annex A 5 – 2 continued: Seasonal influences on the mean adequacy ratios for various nutrients of ex-kwashiorkor, ex-marasmic patients and controls (outlier removal or trimmed mean)

Seasons / **Groups**	**Mean Adequacy Ratio for Various Nutrients (Nutrient Intake as Percent of RDA,DRI)**									
	Energy	Protein	Fat	Calcium	Iron	Phos-phorus	Thiamine	Riboflavin	Niacin	Ascor-bic acid
August – Nov.										
Marasmus										
Mean	91.9	101.1	30.5	95.3	122.4	102.9	79.7	99.8	56.2	48.2
SD	42.5	51.7	17.1	75.1	106.6	49.5	57.4	52.3	28.7	33.6
Median	87.0	87.3	35.3	81.5	63.5	86.6	67.1	90.8	55.9	48.9
December – March										
Control										
Mean	120.1 **	153.5 **	50.6 (*)	155.5 ***	220.2 **	199.4 **	100.9 *	183.4 ***	68.4	83.1
SD	56.9	72.7	31.6	32.1	121.7	154.0	67.3	151.3	35.2	38.7
Median	123.9	138.1	39.8	156.1	189.9	183.9	65.6	144.6	55.6	89.9
Kwashiorkor										
Mean	67.2	78.6	26.9	89.7	134.0	94.8	61.0	98.8	42.4	74.9
SD	37.4	74.3	21.2	92.1	86.5	77.7	59.7	71.4	35.4	75.9
Median	60.8	68.4	23.6	81.0	110.0	78.0	44.9	77.1	38.4	57.2
Marasmus										
Mean	70.6	115.5	34.9	79.8	146.7	117.8	83.3	157.2	54.1	64.0
SD	39.8	57.3	28.0	32.5	93.1	98.3	58.3	213.7	29.3	38.4
Median	74.3	122.6	30.9	79.6	118.2	101.2	95.6	84.5	57.1	44.6

Asterisk/s denote a significant difference in the mean nutrient intake adequacy of control, ex- kwashiorkor and ex-marasmic children

*p<0.05,**p<0.01,***p<0.001,(*)p<0.1

Annex A 5 – 3: Seasonal influences on the mean adequacy ratios for various nutrients of post-kwashiorkor and post-marasmic children

Seasons Groups	Mean Adequacy Ratio for Various Nutrients (Nutrient Intake as Percent of RDA,DRI)									
	Energy	Protein	Fat	Calcium	Iron	Phosphorus	Thiamine	Riboflavin	Niacin	Vitamin C
April – July										
Kwashiorkor										
Mean	76.9	82.1	24.4	103.1 **	116.0	104.3	46.7	69.6	46.7	53.8
SD	36.6	71.7	26.0	54.1	50.4	78.8	55.0	31.1	33.8	35.3
Median	73.4	64.6	14.7	90.0	111.6	71.0	22.2	63.8	43.9	43.2
Marasmus										
Mean	64.1	94.3	29.5	58.6	123.6	115.6	52.6	55.4	46.0	64.1
SD	31.9	77.9	24.7	26.5	108.4	109.6	28.9	18.4	33.0	90.4
Median	55.3	80.0	24.7	59.6	93.8	93.8	48.7	57.0	41.8	39.6
August – Nov.										
Kwashiorkor										
Mean	106.1	141.0	46.8	121.6	178,6	161.1	83.1	124.4	64.0	59.4
SD	57.7	77.1	42.9	85.4	107.9	66.8	44.7	99.6	32.6	55.4
Median	93.9	131.7	34.5	108.3	140.1	157.7	81.4	96.3	51.3	93.9
Marasmus										
Mean	83.6	112.4	34.4	86.6	122.8	143.7	82.7	82.8	57.9	58.0
SD	39.0	59.9	26.5	52.0	59.0	95.4	48.1	49.4	31.2	48.5
Median	80.5	94.3	29.6	77.5	116.1	113.2	70.0	68.4	49.9	53.6
Dec.-March										
Kwashiorkor										
Mean	68.7	91.8	27.3	102.4	104.9 (*)	97.4	54.6 *	103.0	39.2	64.6
SD	52.4	99.1	31.1	51.7	58.2	96.9	72.0	70.7	26.2	42.8
Median	60.7	63.7	17.1	101.2	102.9	70.6	32.2	82.8	32.8	64.7
Marasmus										
Mean	85.5	114.5	39.7	111.1	162.8	144.4	85.8	142.8	59.8	73.7
SD	41.3	71.6	28.5	125.4	100.4	101.3	66.9	163.4	45.8	55.0
Median	71.3	100.8	31.4	85.9	161.1	125.3	62.0	80.0	48.8	54.7

Asterisk/s denote a significant difference in the mean nutrient intake adequacy of control, ex- kwashiorkor and ex-marasmic children

* p<0.05,** p<0.01,***p<0.001,(*)p<0.1

Annex A 5 – 4: Estimation of mean absolute daily intake (g) of essential amino acids in non-oedematous and oedematous children in the seasons

Season/ Groups	**Iso-leucin**	**Leu-cin**	**Lysin**	**Cysmet***	**AAA****	**Trypto-phan**	**Threo-nine**	**Valin**
April to July								
Non-oedematous								
Mean	.87	2.14	.95	.75	1.83	.20	.80	1.08
SD	.57	1.50	.67	.51	1.24	.14	.52	.68
Median	.74	1.94	.78	.68	1.67	.16	.70	.94
Oedematous								
Mean	.57	1.45	.58	.51	1.22	.14	.53	.71
SD	.42	1.20	.42	.40	.95	.10	.39	.51
Median	.44	1.11	.52	.40	.94	.12	.42	.55
August-November								
Non-oedematous								
Mean	1.23	3.09	1.22	1.11	2.61	.29	1.12	1.53
SD	.66	1.71	.74	.63	1.42	.15	.59	.81
Median	1.10	3.03	1.05	1.03	2.46	.28	1.07	1.37
Oedematous								
Mean	.91	2.46	.86	.83	1.98	.23	.83	1.14
SD	.45	1.29	.48	.42	.99	.00	.41	.56
Median	.88	2.34	.87	.84	1.89	.23	.81	1.09
December - March								
Non-oedematous								
Mean	1.12	2.60	1.26	.91	2.27	.24	1.04	1.40
SD	.63	1.72	.67	.57	1.35	.13	.60	.79
Median	.98	2.03	1.16	.76	1.92	.21	.87	1.21
Oedematous								
Mean	.74	1.76	.83	.60	1.50	.17	.68	.93
SD	.67	1.59	.87	.50	1.35	.15	.58	.79
Median	.56	1.23	.56	.45	1.15	.12	.53	.71

*Cysmet= methionine, cystine (sulfur-containing amino acids) ()
**AAA=aromatic amino acids : phenylalanine, tyrosine and tryptophan

ANNEX B

QUESTIONNAIRES INCLUDING “ACTIVITY PROFILE” AND OBSERVATION GUIDE

- HOUSEHOLD REGISTRATION FORM -

Patient NO:__________________

Name:______________________ **Address of patient:_______________________**

Date of registration:____/____/____(day/month/year) **Registered by:____________**

I. GENERAL INFORMATION

Age: _____years_____months Sex: ______ 1=male 2=female

Weight:_______kg Height:___________cm

Clinical Classification: _______ 1=Kwashiorkor 2=Marasmus 3=Underweight
Welcome Classification:_______ 1=Kwashiorkor 2=Marasmic Kwash. 3=Marasmus 4=Underweight
Mother's name:____________________________
Marital status of the mother: ____________
1= married with the father of the child 2= married with another man, not the father of the child
3= seperate 4= divorced 5= polygamous 6= widowed 7= single

Mother alive: _______ 1=yes 2=no
Father alive: ________ 1=yes 2=no

Name of Head of Household:__________________________________

II. Members of the household

N0.	NAME	AGE years	months	SEX 1=male 2=female	RELATION use code below	EDUCATION use code below

Code for RELATION: 0=patient 01=father 02=mother 03=sibling of patient
04= uncle 05=Aunt 06=cousin of patient
07=Grandfather/mother 08=stepfather
09=stepmother 77=other (specify in table)
Code for EDUCATION: 1=not able to read and write 2=able to read and write
3=traditional school 4= primary school
5=secondary school and above

III. RELIGION, ETHNICITY, OCCUPATION

Religion: 1=Christian 2=Moslem 3=Traditional 4=others _______
Believe in spirits: ________ 1=yes 2=no

Ethnicity: 1=Sidamo 2=Oromo 3=Gurage 4=Kembata 5=Hadiya
6=Amhara 7=others _______

Occupation of head of household: 1=farmer 2=Civil servant 3=laborer 4=merchant
5=others, specify:____________
____

IV. VITAL EVENTS

A: Illnesses last month

NO.	Name	Illness	Duration days	months	years

Code for Illness: (if clearly diagnosed illness, please specify in table!)
01=diarrhoea 02=worms expelled
03=cough of short duration+ 04=chronic caugh+blood in sputum
05=fever 06=fever with chills
07=jaundice 08=skin rashes
09=stiffness of neck 10=loss of appetite
11=loss of weight 12=measles
13=swelling of the body 14=scabies
15=accident 99=others

B. Deaths (during the last five years)

NO.	Name	Age at years	Relation codes No.II.	Sex 1=m 2=f	Cause use code below

Code for cause:
01= diarrhoea/vomitting 02=jaundice 03=caugh for short duration+difficulty of breathing
04=chronic caugh+blood 05=fever 06=fever with chills 07=stiffness of neck
08=stiffness of neck 09=measles 10=accident 77=others, specify!

V. Housing

Size:_________diameter/m² **No. of compartments:__________**

VI. Water

Drinking water from: _________
1=tab 2=protected well 3=unprotected well 4=spring 5=other

FOLLOW UP FORM - HEAD OF HOUSEHOLD Form **B**

Form No: __________ Patient No:. __________

Name of Patient: ______________________________________

Name of Head of Hh: ______________________________________ Age of Hh: ¦_______¦years

Address of patient ____

Date of registration:___/____/___/ Registered by:__________________________

Inpatient ¦___¦ Outpatient ¦__¦

I. Newcomers to household

N0.	NAME	AGE years	months	SEX 1=male 2=female	RELATION use code below	EDUCATION use code below

Code for RELATION: 0=patient 01=father 02=mother 03=sibling of patient
04= uncle 05=Aunt 06=cousin of patient
07=Grandfather/mother 08=stepfather
09=stepmother 99=other (specify in table)

Code for EDUCATION: 1=not able to read and write 2=able to read and write
3=traditional school 4= primary school
5=secondary school and above

II. Vital Events

A. Births/Deaths

Any pregnant woman in family: 1=yes 2=no ¦___¦
Any livebirths during last 4 months: 1=yes 2=no ¦___¦
Any deaths during the last 4 months: 1=yes 2=no ¦___¦
If yes, please complete the following table:

N0.	NAME	AGE years	months	SEX 1=male 2=female	VITAL EVENT 1=birth 2=death	CAUSE of death

Code for cause of death:
01= diarrhoea/vomitting 02=jaundice 03=caugh for short duration+difficulty of breathing
04=chronic caugh+blood 05=fever 06=fever with chills 07=stiffness of neck
08=stiffness of neck 09=measles 10=accident 77=others, specify!

B: Illnesses since last visit (last 4 months)

NO.	Name	AGE y m	SEX 1=m 2=f	Illness	Duration days	months	years

Code for Illness: (if clearly diagnosed illness, please specify in table!)
01=diarrhoea 02=worms expelled
03=cough of short duration+ 04=chronic caugh+blood in sputum
05=fever 06=fever with chills
07=jaundice 08=skin rashes
09=stiffness of neck 10=loss of appetite
11=loss of weight 12=measles
13=swelling of the body 14=scabies
15=accident 77=others

III. FOOD PRODUCTION, INCOME, EXPENDITURES

1. If you work on the farm, what types of crops do you grow, what was the quantity of harvest **the last four months (last visit)**, how much was the total cash obtained?

Crop	Harvest sinced last visit (Units)	Number sold (Unit)	Price (last year)	Number consumed	Number spoiled

Codes:**Crop**: 1= ensete 2= coffee 3= maize 4=teff
5= red kidneys 6= horse beans 7= wheat 8=barley
9= tabacco 10=cow peas 11=peas 12=chat
13=lentilles 77= others, specify____________________

2. Were there any plant diseases or other factors influencing the product of the harvest in the last four months? 1=yes 2=no ¦___¦

If yes, describe:

____

____

3. If you have a farm, what types of crops/vegetables/fruits do you grow, what was the quantity of **the last four months (last visit)**, how much was the total cash obtained?

Crops	**Vegetabl e/Fruits**	**Harvest sinced last visit**	**Number sold (Unit)**	**Price**	**Number consumed**	**Number spoiled**

Codes: **Crop**: 1= ensete 2= coffee 3= maize 4=teff
5= red kidneys 6= horse beans 7= wheat 8=barley
9= tabacco 10=cow peas 11= peas 12= chat
13=lentilles 77=others,specify____________________

Codes **vegetables/fruits: V**
1=gommon 2=tkale gommon 3=carottes 4=potatoes
5=godere 6=boyna 7=sugar cane 8=avocado
9=bananas 10=papayas 11=oranges 12=ananas
13=passion fruit 14=guavas 15=oxen heard
77=others,specify_______________

4. Did you have **food shortages** sinced last visit/last four months?
if yes, when and what type of food? 1= yes 2= no ¦________¦

Time of food shortage	**Type of food**

Codes: see question 3

5. Did you have water shortage since the last visit? 1=yes 2=no ¦___¦
If yes, during what months:____

6. In case of **livestock** ownership, state number of livestock and number consumed and sold in the **last four months.**

Livestock	**Number**	**Number consumed by family**	**Number sold**	**Price (Birr)**

Codes Livestock: 1= cows 2= goats 3= sheep
4= donkeys 5= chicken 6=oxen 77= others, specify:______________

7. State products of your livestock (cow, chicken, goat) - daily average of the **last four months/ last visit?**

Livestock-products	**Amount (Unit)**	**Amount (Unit) sold**	**Amount (Unit) used**
Goat :milk			
Cow : milk			
Chicken: eggs			

8. Which food items you bought **the last 3 months** at the market, neighbours? **Use codes**

Food items-use **codes Q.no.4**!	Birr/Cents	Amount of food items (kg, dunkey rolls, horse roll)

9. What was the household cash income during **last four months**?
(included income from farming) ¦______¦Birr

10. State **sources of household income** during the last four months and amount from each source

Sources	**Amount**

11. What were your **total expenditures** in the last four months? ¦______¦Birr

12. What were your **food expenditures** in the last four months? ¦______¦Birr
How much out of **this income** you gave to your wife/care taker? ¦______¦Birr
(last four months/last visit)

13. Did the family had any **problems in daily life** sinced last visit? P1¦___¦ P2¦___¦ P3¦___¦
1=shortage of food 6=lack of coffee
2=shortage of cash 7=shortage of farm land
3=frequent illness 8=low soil fertility
4=poor housing condition 9=lack of seeds
5=lack of health facilities 10=livestock diseases
11=plant diseases 12=shortage of grazing land
77=other, specify_______________________________________

14. Concerning the nutrition of your child (patient), did you change anything in the food pattern sinced last visit? 1=yes 2=no ¦_____¦

If yes, what have you changed?____

REGISTRATION FORM - CARE TAKER (CT)   Form **A**

Form No: __________   Patient No: __________

Name of Patient: ___________________________________ Age of Patient: ¦____¦months

Name of CT : ___________________________________Age of CT: ¦____¦years

Relation to patient: ___________________________________
1= mother 2=grand mother 3=aunt 77=others, specify______________________

Weight of CT (in kg) ¦_____ ¦kg   Height of CT (in cm) ¦_____ ¦cm

Address of patient: ____

Date of registration:_____/_____/_____/   Registered by:_______________________________

Inpatient ¦___¦   Outpatient ¦___¦

I. GENERAL INFORMATIONS

1. How often have you been pregnant? ¦_____¦
   How many of them were: - liveborn: ¦_____¦
   - born dead: ¦_____¦
   - miscarriages: ¦_____¦

   How many of the liveborn children died: < 1 year: ¦_____¦
   1 - 5 years: ¦_____¦
   > 5years: ¦_____¦
2. Did ever one of your child other than the patient had swelling of the body
   1=yes 2=no ¦_____¦

3. Did you have own cash income sources the last three months?
   1=yes 2=no 3=sometimes ¦_____¦

4.a. If yes, what kind of occupation do you have?_______________________________

b. How many days a week you work for this occupation? ¦_____¦hours

c. When you work, who takes care of the child? ¦_____¦
   1=grandmother 2=mother in law 3=older sibling
   77=others,specify___________________

5.a. What is your income from your occupation in the **last four months**? ¦_____¦Birr

b. How much money you got in the **last four months** from relatives
   (head of household, parents etc.) ¦_____¦Birr

6. What is the average of your **last four months total expenditures**? ¦_____¦Birr

7. What is the average of your **last three months expenditures for food**? ¦_____ ¦Birr

8. Did you get **food gifts** the last four months? 1=yes 2=no ¦_____¦Birr
   If yes, what kind of food and how much?
   ____
   Did you change some foods with neighbours, relatives etc.? 1=yes 2=no ¦_____¦
   Birr
   If yes, what food and how much ____

9. How often per week you usually go to the market? ¦_____¦

10. Who provides money for the food prepared for the household? ¦_____¦
    1=husband 2=herself 3=parents 4=others, specify_______ ¦_____¦ ¦_____¦

11. State months of highest workload:_______________________________________

12. Do you prepare special meal for underfives? 1=yes 2=no ¦_____¦

13. If yes, what kind of food you prepare special for children under 5 years of age?
    ____
    ____

14. From whom do you know how to feed the child? ¦_____¦
    1=mother 2=school 3=grand mother 4=mother in law 5=others ¦_____¦

15. Which are the three major problems in your daily life? P1 ¦___¦ P2 ¦___¦ P3 ¦___¦
    1=shortage of food 7=school fees
    2=shortage of cash 8=not enough farm land
    3=frequent illness 9=too much workload
    4=poor housing condition 10=whether
    5=lack of health facilities 11=lack of equipment/tools
    6=lack of coffee 77=others, specify______________________

16. How far is the nearest health facility to you?
    (How long you have to walk to the nearest health facility?) ¦_____¦

17. Do you make use of it? 1=yes 2=no ¦___¦

18. If not, why you dontt use it?
    1=too expensive 5=drugs not available
    2=too far 6=no personal
    3=does not help to improve sickness 7=prefer herbs/traditional medicine
    4=not functioning 8=other, specify____________ ¦___¦

19. Is your child immunized? 1=yes 2=no ¦___¦

Immunisation	1.	2.	3.
DPT	____	____	____
Polio	____	____	____
Measles	____	XXX	XXX
BCG	____	XXX	XXX

FOLLOW-UP CARE TAKER **Patient No.________** **Form A**

GENERAL INFORMATIONS -Informations concerning the last 4 months

1. Which were the three major problems in your daily life?P1 |___| P2|___| P3|___|

1=shortage of food	7=school fees
2=shortage of cash	8=not enough farm land
3=frequent illness	9=too much workload
4=poor housing condition	10=whether
5=lack of health facilities	11=lack of equipment/tools
6=lack of coffee	77=others, specify___________________________

2. Did you have own cash income sources the last 4 months?
1=yes 2=no 3=sometimes |______|

3.a. If yes, what kind of occupation did you have?_______________________________

b. How many days a week you worked for this occupation? |______|days

c. When you work, who takes care of the child? |______|

1=grandmother 2=mother in law 3=older sibling
77=others,specify__________________

4.a. What were your **income** from your occupation in the last 4 months? |______|Birr

b. How much money you got in the last 4 months from relatives
(head of household, parents etc.) |______|Birr

5. What was the average of your last 4 months **total expenditures**? |______|Birr

6. What was the average of your last 4 months **expenditures for food** |______| Birr

7. Did you get **food gifts** the last 4 months? 1=yes 2=no |______|Birr
If yes, what kind of food and how much?

____

8. Did you change some foods with neighbours, relatives etc.? 1=yes 2=no |______|Birr
If yes, what food and how much ?

____

9. How often per week you went to the market the last 4 months? |______|

10. Who provided the money for the food prepared for the household? |_______|
1=husband 2=herself 3=parents 4=others,specify_________ |_______|

11.a. Did you have **food problems** (not enough food) the last 4 months?
1=yes 2=no |______|

b. If yes, which food items were not enough?

____

____

CARE TAKER **Form B**

Form No:___________________ **Patient No:___________________**

Name of index child:____________________ Name of sibling:_____________________

Weight of patient:________kg Age:______y-m Weight of sibling:______kg Age:_____

Name of the respondent:____

Relation to patient:_____ 1=mother 2=grandmother 3=aunt 77=others, specify:_________

Date of registration:_____/_____/______/ Registered by :_____________________________

1. **Daily Diet:** 1=yes 2=no

Kocho and milk: ____ Kocho and maize: ____

Kocho and maize and red kidney: ____ others, specify:______________________

2. How often and how much did your child eat the following food **the last 7 days**

	patient	**patient**	**sibling**	**sibling**
Food	**Frequency of Consumption**	**Amount usually given (coffee cups etc)**	**Frequency of Consumption**	**Amount usually given (coffee cups etc)**
Animal proteins	-------	---------	--------	---------
Meet				
Egg				
Starches	--------	---------	---------	---------
Ensete				
Maize				
Tef				
Barley				
Wheat				
Potatoes/sweet potatoes				
Red kidney				
Ater/bakela/lentilles				
Vegetables	---------	---------	---------	---------
Gommon				
Tkale Gommon				
Duba				
Onion				
Green Pepper				
Fruits	---------	---------	---------	---------
Avocados				
Bananas				
Oranges				
Papaya/Mango				
Passion fruit (hope)				
Guava (zeitone)				
Oxen heart				
Oil				
Butter				
Shaking Milk				
Cow milk boiled 1=y 2=n ___				

Codes: 0=Never 2=2 times 4=4 times 6=daily more than once
1= once 3=3 times 5= daily once 77= others

2. How many meals did the children (investigated) eat **yesterday**?
1=Once 4=4 times
2=2 times 77=others, specify_______ child investigated ¦___¦
3=3 times sibling ___

3. Did you give some special food for child investigated/sibling **yesterday**?
1=yes 2=no child investigated ¦___¦
sibling ¦___¦

If yes, what kind of food and how often?

Child	Food/drinks	Frequency
child investigated		
sibling		

4. Left-overs from childs plate were given later to child 1=yes 2=no ¦___¦
If yes, 1=warmed up 2=cold ¦___¦

5. **Individual Food Record (one day) - Home visit**

Respondent for preparation: ______________________

Time	Kind of food	Source	Weight of **food** for **total household** (g)	Weight **after preparation**	Weight of **food** of **child** (g) m1	Weight of **leftover of child** (g) m2	Net intake (g) m1-m2=m3

Codes for food sources:
1=bought 2=owngrown 3=gift 4=barter

Activity Profile of Care Taker and child(ren) investigated

Time	**Activity of Care Taker**	**Activity of Child(ren)(observation)** 1=child investigated 2=sibling investigated

Codes for care taker activity:
01=housewok 02=personal hygiene 03=cleaning the child 04=cleaning sibling
05=work with pouldry and livestock 06=work in the garden-Ensete
07=visit to neighbours/friends/relatives 08=market 09=prepare breakfast
10=prepare lunch11=prepare lunch 12=prepare dinner 13=eating time
14=fetching wood 15=fetching water 16=occupying with child
17=occupying with siblings,head of household etc 18=drink coffee 77=others,specify!
Codes for activity of child:
01=sleeping 02=sitting outside 03=sitting inside the house
04=sitting at the fire 05=eating 06=playing alone
07=playing with siblings, other children 08=child is washed or washes itself 77=others,specify!

Mealtime behaviours /Observations:

(Demand of children, Distribution of meal, Preferences)
Observations of feeding behaviour have to be done in order to assess who distribute the food; whether hands are washed, whether children ask for more; if they receive more whether it was requested, offered, or simply taken; and who take the initiative in beginning the meal.Are some members of the household getting better food? If yes, who?

Observation guide for fieldvisit

1. Are the hands washed before eating food?

Members of household	Hands washed 1= yes 2=no
Head of household	
Care taker	
Child investigated	
Sibling investigated	
Other children	

2. Who asks for more food, does he/she gets also more?

Householdmember who asks for more	Does he/she gets more? 1=yes 2= no

3. Who take the initiative in beginning the meal? ____

4. Are some members of the household getting better or more/less food?

Members of household	**better food** 1=yes 2=no	**amount of food** 1=more 2=less 3=normal
Head of household		
Child investgated		
Sibling investigated		
Other children:		

5. Which members of the household go somewhere else eating **additional** food?

Members of household	**Market** 1=yes 2=no	**Neighbour/friends** house 1=yes 2=no	**Garden** 1=yes 2=no	**Others**,specify: 1=yes 2=no

6. Which member of the household gets enough food, which not?

Member of household	Get enough food 1=yes 2=no
Head of household	
Caretaker	
Child investigated	
Sibling investigated	
Other children:	

7. Does the child investigated has its own plate? 1=yes 2=no ¦___¦
Does the sibling investigated has its own plate? 1=yes 2=no ¦___¦

Cooking

1. Who is cooking on this day? ___________________________________

2. Is the wood too wet for cooking? 1=yes 2=no ¦___¦
Why do they use wet wood?____

3. Are the cooking utensils clean? 1=yes 2=no ¦___¦

4. Are the hands washed before cooking? 1=yes 2=no ¦___¦

5. Which kind of plates/cups/dishes are used? Are they clean?

Members of household	Kind of dishes *Use codes!*	Clean 1=yes 2=no

Codes for dishes: 1= ensete leaf 2=coffee cups 3=plates
4=plastic cup (red) 77=others, specify____________________

6. Does the care taker prepare food too late? 1=yes 2=no ¦___¦

7. Are leftovers given later 1=warmed up 2=cold 3=both ¦___¦

Housing

1. Does the care taker clean the floor? 1=yes 2=no ¦___¦

2. Does child(ren) investigated have contact to dirty floor (cows urin place) 1=yes 2=no ¦___¦

3. Does child investigated eat parts of dirt, soil? 1=yes 2=no ¦___¦

4. Are the clothes clean 1=yes 2=no ¦___¦

5. Are there flies in the house? 1=yes 2=no ¦___¦

6. Is there a rat or other rodens in the house? 1=yes 2=no ¦___¦

7. What kind of food are stored in the house and where?______________________________

____

8. Are there insects in the food stored? 1=yes 2=no ¦___¦

9. Is the Kocho stored in the hole clean? 1=yes 2=no ¦___¦

10.Is prepared food left covered? 1=yes 2=no ¦___¦

11. How do they dry their wood? 1=through burning 2=through drying in the sun ¦___¦

12. Is there too much smoke in the house because of too long burning of wood or gaz? ¦___¦

13. How much money they usually need to buy fuel for the lamp in a week ¦___¦ Birr

14. Are there some changes since the last 4 months in the equipment found in the house?
1=yes 2=no ¦___¦

If yes, what has changed?____

____

15. What kind of bedding facilities there are?

Sleeping place	Members of the Hh using this sleeping place	No. of peoples	No. of anesola	No. of birdelips	No. of gabi

Codes for sleeping place: 1=local bed (wooden bed + dry Ensete leaves etc.)
2=mats (celen) 3=dry ensete leaves 4=cow skin

16. Is there a lack of blankets? 1=yes 2=no ¦___¦
If yes, for whom it is not enough?____

17. Is it cold in the house during the night? 1=yes 2=no ¦___¦

18. If yes, is it because of leak house? 1=yes 2=no ¦___¦

19. Is the rain coming into the house? 1=yes 2=no ¦___¦

Caretaker and **index child:** ¦____¦ Remarks:
- she gives enough care to the child ¦____¦ ______________________
- treats child similar to the other children ¦____¦ ______________________
- prefers other children ¦____¦ ______________________
- neglects the child ¦____¦ ______________________
- she speaks and plays with the child ¦____¦ ______________________
- she rarely speaks and plays with the child ¦____¦
- she rarely touchs the child ¦____¦

Caretaker and **sibling investigated**: Remarks:
- she gives enough care to the child ¦____¦ ______________________
- treats child similar to the other children ¦____¦ ______________________
- prefers other children ¦____¦ ______________________
- neglects the child ¦____¦ ______________________
- she speaks and plays with the child ¦____¦ ______________________
- she rarely speaks and plays with the child ¦____¦
- she rarely touchs the child ¦____¦

Care taker
- is lazy ¦____¦
- is too busy ¦____¦
- don't control the index child ¦____¦
- don't control the sibling ¦____¦
- don't control any child ¦____¦
- is ill or tired ¦____¦

Index child and siblings/neighbour children:
- they actively play and talk together¦____¦
- they rarely play and talk together¦____¦
- good contact to other children ¦____¦

Sibling investigated to siblings/: neighbour children
- they actively play and talk together ¦____¦
- they rarely play and talk together¦____¦
- good contact to other children¦____¦

Index childs activity:
- actively, playing a lot ¦____¦
- mostly sitting ¦____¦
  - inside ____ outside¦___¦
- mostly happy ¦____¦
- mostly sad, misery ¦____¦
- cries a lot ¦____¦
- mostly tired ¦____¦
- often angry ¦____¦
- open for commu-nication ¦____¦

Siblings activity:
- actively, playing a lot ¦____¦
- mostly sitting ¦____¦
  - inside ¦____¦ outside¦___¦
- mostly happy ¦____¦
- mostly sad, misery ¦____¦
- cries a lot ¦____¦
- mostly tired ¦____¦
- often angry ¦____¦
- open for commu-nication ¦____¦

Head of household to **child**:
he plays and speaks with it, takes care¦____¦

Head of household to **sibling:**
he plays and speaks with it, takes care¦____¦

How is the relationship of the **members of household** to the **neighbours?**
- good relationship ¦____¦
- medium relationship ¦____¦
- not the best relationship¦____¦
- they help eachother ¦____¦
- they drink together coffee¦____¦

Drinking water

1. Which kind of drinking water they use? ¦____¦
   1=protected well 2=unprotected well 3=spring 4=river
   77=others, specify:______________________
2. Is the water pure? 1=yes 2=no ¦____¦
4. How many liters water they bring a day (drinking water and water for other purposes)? ¦____¦ liter
5. Is the container for the drinking water clean? 1=yes 2=no ¦____¦

Household Situation: fill in 1=yes or 2= no

1. Are there problems in the household ? ¦____¦
   If yes, specify:____
   ____
   ____
   ____
2. Is the head of household drinker? ¦____¦
   Is the head of household smoker? ¦____¦
   Is the head of household taking chad? ¦____¦
   Is the head of household selfish? ¦____¦
3. Is the care taker somebody else than the mother? ¦____¦
4. Is the head of household somebody else than the father? ¦____¦
5. Does the care taker control what the children eat?
   child investigated ¦____¦
   sibling investigated ¦____¦
6. Does the care taker control whether hands of the children are washed after defecation and before eating? ¦____¦
7. How is the **relationship between different household members**?

Head of household and **care taker**
- they are nice to eachother ¦____¦
- they help eachother ¦____¦
- they speak together ¦____¦
- they often quarrel ¦____¦
- they dont speak together ¦____¦
- he gives not enough money ¦____¦
- he is dominant ¦____¦

Remarks:______________________
____

Grandfather/mother and **caretaker**
- the relationship is good ¦____¦
- sometimes they quarrel ¦____¦
- the grandmother is dominant ¦____¦

Remarks:______________________
____

ANNEX C: EXAMPLE OF A DIET IN THE HOME OF A CHILD TREATED ONCE FOR KWASHIORKOR

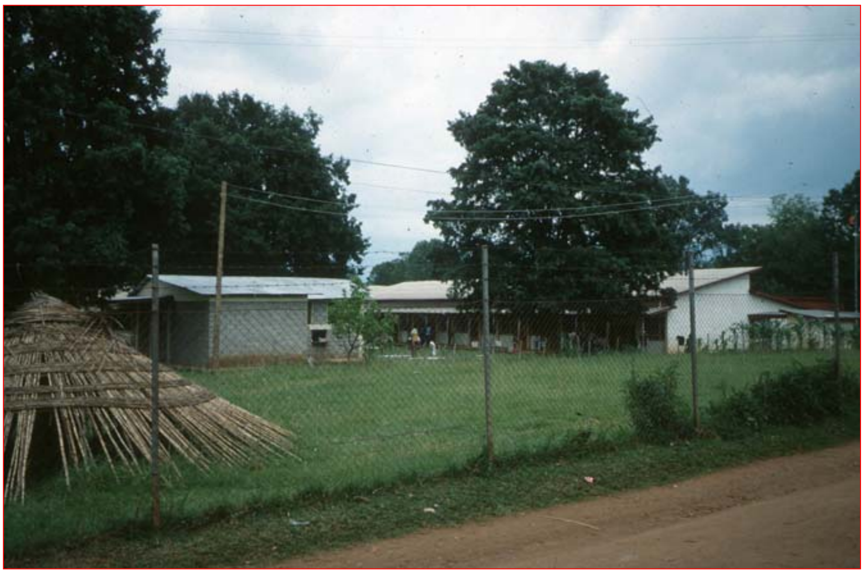
Family background: The family consisted of 6 persons:
Head of household, caregiver and 4 children:
The head of household's former wife died and he married another woman. With his former wife he had three children: one 15 years old girl, one 8 years old boy and one 6 year old girl, which was finally admitted in Yirga Alem Hospital for kwashiorkor.
The father of the children had with his new wife one child, which was at the time of the study 3 years old. The parents took very much care for the youngest child, especially the mother. For the older children the caregiver was a stepmother. On the day of the home visit she bought 3 avocados at the market but gave all of them to her own child. Since the food was not enough for the whole family, the two oldest went to the neighbours and to the family garden to get some fruits in addition. The child who was discharged from hospital some weeks before, was too small and week to go by itself to the neighbours and depended on this food what was given by the stepmother. The child was not satisfied by the food it got, she asked for more, but didn't get more.
The stepmother was in general very inactive. She was the most time out of the house, visiting neighbours, going to a funeral and a wedding without the stepchildren. At funerals and weddings there is food for all visitors, so this was a good opportunity for her to get some food. When she was home, she didn't wash the dishes of the children, she didn't control whether the children wash their hands before eating, whether they finish their food and she was not friendly talking to the step-children. She started very late to cook something. Even though there was more food available in the house she didn't prepare more. To her own child she was very friendly and feeded it by her hand.
The father of the children went out of the home to sell some small amounts of coffee at the market. He in general controlled neither his wife nor the children.

On the day of the home visit the child, a 6 years old girl, ate following food:

Time	Food eaten by the index child
7.35 o'clock	83 g kocho
	60 g red kidney beans (left over from the day before, not reheated)
12.00 o'clock	31 g maize kolo (roasted maize corns)
	79 g coffee
14.40 o'clock	69 g dabo (white wheat bread)
	79 g coffee
	49 g guava
17.15 o'clock	52 g kocho
	51 g maize kolo (roasted maize corns)
	72 g coffee
21.00 o'clock	111 g kocho

The breakfast was in the very early morning, the lunch was at 17.15 o'clock, the dinner at 21.00 o'clock.

PHOTODOCUMENTATION

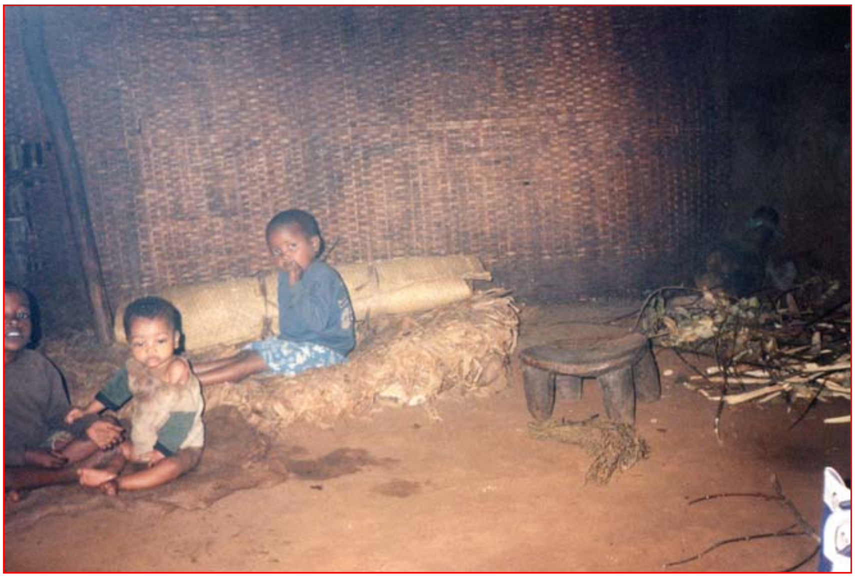


Yirga Alem hospital

Sidama hut surrounded by Ensete trees

Former kwashiorkor patient of Yirga Alem hospital in front of his home

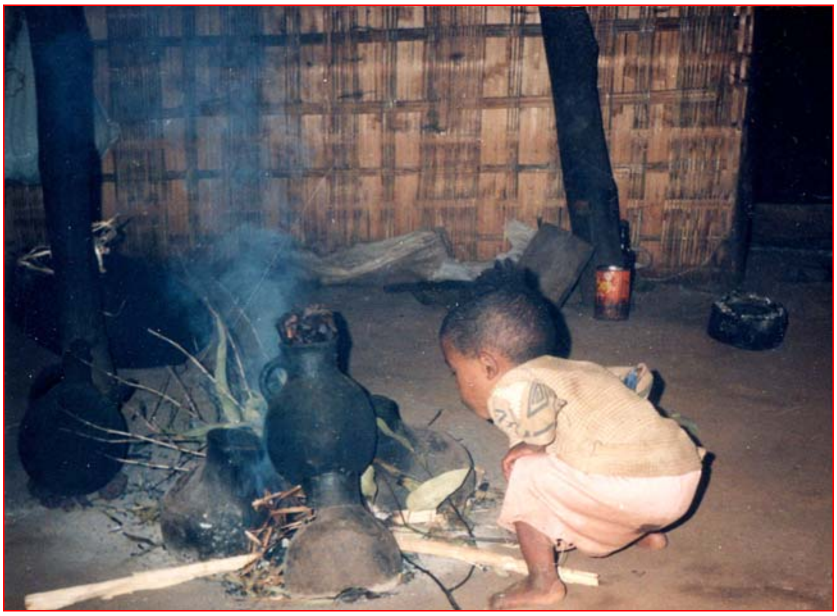
Cleaning the house (scattered) in the morning, smoke in the house produced by fire making – caregiver of the child is the grandmother



Former PEM-patient sitting in the house waiting for food

Kitchen and sleeping place in side a house of a family with a kwashiorkor child

Children making fire with wet leaves



Child being alone in the house-keeping the fire ...

... burning

coffee ceremony – former kwashiorkor child drinks coffee

Packing „kocho“ for selling – income source for women in Sidama

Baking „injera“ in the house – income source for women in Sidama